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MEDUSAE OF THE WORLD

VOLUME II

THE HYDROMEDUSAE

BY

ALFRED GOLDSBOROUGH MAYER

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MEDUSAE OF THE WORLD.

THE HYDROMEDUSAE.

Order LEPTOMEDUSÆ (Continued).

Family EUCOPIDÆ Gegenbaur, 1856.

Eucopidæ, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 241.—Haeckel, 1879, Syst. der Medusen, p. 161.—Maas, 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 20; 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 31.

FAMILY CHARACTERS.

Leptomedusæ with lithocysts, and with less than 8 radial-canals upon which the gonads are developed.

The great majority of these medusæ have 4 radial-canals, and none are known to have more than 6 radial-canals. They develop through alternation of generations from Campanularian hydroids. The Eucopidæ are possibly derived from the more simply organized Thaumantiadæ. Indeed, the young medusæ of the subfamily Eireninæ of the Eucopidæ lack marginal lithocysts, and in this respect resemble the adult stages of the medusæ of the Thaumantiadæ.

Asexual budding is exceedingly rare in the medusæ of the Eucopidæ. In all known forms the marginal ring-canal is simple and does not give rise to blindly ending, centripetal vessels.

The lithocysts are open or closed folds of the velum at the bell-margin, and the concretions are always of ectodermal origin and are ennervated by the inner nerve-ring.

The Eucopidæ, being dependent for their development upon a fixed hydroid stage, are not commonly found far out at sea, but are very abundant along shores, the shallow waters of which afford suitable habitats for their hydroids.

We may divide the Eucopidæ into two cohorts, the first being composed of the subfamilies Obelinæ and Phialinæ in which the stomach either lacks a peduncle or is mounted upon a very short, wide, flaring peduncle, which is always readily distinguished from the elongate, prominent peduncle of the second cohort composed of the subfamilies Euteminæ and Eireninæ. There are very few intergrading forms with peduncles of only moderate length, and one is never in doubt as to which cohort a given medusa belongs.

The synopsis of the genera of Eucopidæ follows.

Subfamily Obelinæ: Eucopidæ with 8 adradial lithocysts. Manubrium without a well-developed peduncle.

Eucopella von Lendenfeld, 1883. Degenerate medusa without manubrium or tentacles. The 4 radial-canals give rise to side branches upon which gonads are developed. Closed vesicular lithocysts. Hydroid: *Eucopella* von Lendenfeld.

Agastra Hartlaub, 1897. Degenerate medusa without manubrium, but with rudimentary tentacle-bulbs. No cirri, 4 sac-like gonads upon the 4 simple radial-canals. Closed vesicular lithocysts.

Eucope Gegenbaur, 1856. Closed vesicular lithocysts upon bell-margin between tentacles. Basal bulbs of tentacles simple and hollow and do *not* extend inward into gelatinous substance of bell. No cirri. Hydroid: *Campanulina* Van Beneden.

Obelia Péron and Lesueur, 1809. Closed vesicular lithocysts placed upon subumbrella side of basal bulbs of 8 tentacles. Entodermal cores of all tentacles extend inward into gelatinous substance of bell. No cirri. Hydroid is *Obelia*.

Tiaropsis L. Agassiz, 1849. Lithocysts are open folds of velum containing numerous concretions. Entodermal ocellus above each lithocyst. Tentacles numerous with simple, hollow basal bulbs. No cirri. Hydroid unknown.

Cosmetira Hartlaub, 1909. Lithocysts in 8 open folds of the velum. Tentacles of two sorts—large hollow ones arising from the bell-margin, and small cirrus-like ones arising from the sides of the exumbrella above the margin and also from the margin itself.

Subfamily Phialinæ: Eucopidæ with more or less than 8 lithocysts. Manubrium without a well-developed peduncle.

Clytia Lamouroux, 1812=*Epenthesis* McCrady. 16 tentacles alternating with 16 closed, vesicular lithocysts. No cirri. 4 radial-canals. Hydroid: *Clytia*.

Phialidium Leuckart, 1856=*Oceania* L. Agassiz, 1862. 16 or more tentacles, and even more numerous closed vesicular lithocysts. No cirri. No permanently rudimentary tentacle-bulbs. 4 radial-canals. Hydroid: *Campanulina* Van Beneden.

Phialucium Maas, 1905. Similar to *Phialidium*, but with some permanently rudimentary tentacle-bulbs upon bell-margin. Hydroid unknown.

Phialopsis Torrey, 1909. Similar to *Phialucium* but with cirri upon the bell-margin.

Blackfordia Mayer. Numerous tentacles and numerous closed vesicular lithocysts. Entodermal cores of some or all tentacles project inward into gelatinous substance of bell. 4 radial-canals. No cirri. Hydroid unknown. No permanently rudimentary tentacles.

Pseudoclytia Mayer, 1900. 5 radial-canals, 5 lips, 5 gonads. Numerous tentacles and lithocysts. Hydroid unknown.

Gastroblasta Keller, 1883. With 2 or more manubria. Numerous lithocysts and tentacles. No cirri. Hydroid unknown.

Eucheilota McCrady, 1857. 4 or more closed vesicular lithocysts and 4 or more tentacles, with marginal or lateral cirri. 4 radial-canals. Hydroid unknown.

Mitrocoma Haeckel, 1864=*Phialis*+*Microcomium*+*Mitrocomella*+*Mitrocoma* Haeckel, 1879. Lithocysts open folds of velum. Numerous tentacles with marginal or lateral cirri. 4 radial-canals. Hydroid: *Cuspidella* Hincks.

Staurophora Brandt, 1834=*Staurostoma*+*Staurophora* Haeckel, 1879. Mouth an open, cruciform, gutter-like slit extending along the 4 radial-canals. Gonads developed in curtain-like walls of mouth. Numerous lithocysts sunken within ectoderm of subumbrella side of velum.

Subfamily Eutiminæ: 8 adradial lithocysts. Stomach mounted upon a long gelatinous peduncle. Tentacles arise from bell-margin.

Saphenia Eschscholtz, 1829. With 2 well-developed, radially placed tentacles, 180° apart. Numerous cirri. Gonads upon the 4 radial-canals. Hydroid unknown.

Eutima McCrady, 1857=*Eutima*+*Eutimeta*+*Octorchis*+*Octorchandra*+*Eutimalphes* Haeckel, 1879. With 4 or more tentacles. Numerous cirri or marginal warts. 4 or 8 gonads upon the 4 radial-canals.

Eutimium=*Eutimium*+*Octorchidium* Haeckel, 1879. With 4 or more tentacles. No cirri. 4 or 8 gonads upon the 4 radial-canals.

Subfamily Eireninæ: More than 8 lithocysts. Stomach mounted upon a long gelatinous peduncle. Tentacles arise from bell-margin.

Phortis McCrady, 1857. 4 or more tentacles without marginal or lateral cirri. Gonads on 4 radial-canals. Hydroid: *Phortis* Brooks, 1882.

Irenopsis Goette, 1886. 6 or more tentacles, 6 gonads on the 6 radial-canals, 6 lips. No cirri. Hydroid unknown.

Eirene Eschscholtz, 1829=*Irene*+*Irenium* Haeckel, 1879. 4 or more tentacles, numerous marginal warts or cirri. 4 or 8 gonads which occupy only limited portions of the 4 radial-canals. Hydroid: *Campanulina* ?

Tima Eschscholtz, 1829. Similar to *Eirene*, but gonads occupy entire lengths of the 4 radial-canals. Hydroid: *Campanulina* ?

Subfamily OBELINÆ.

Eucopidæ with 8 adradial lithocysts. Manubrium without a peduncle.

Genus EUCOPELLA von Lendenfeld, 1883.

Eucopella, von Lendenfeld, 1883, Zeit. für wissen. Zool., Bd. 38, p. 497; 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 607.—Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 568.

Eucopella is distinguished from *Campanularia* by its free-swimming medusa. In other respects the hydroid of *Eucopella* is a true *Campanularia*. The type species is *Eucopella bilabiata* from Australia. It is probable that this species ranges from Australia to Alaska and California. It was first described by Coughtrey from New Zealand under the name "*Campanularia bilabiata*."

GENERIC CHARACTERS.

Eucopidæ without manubrium and without tentacles. With 8 adradial lithocysts. With 4 radial-canals which give rise to blindly ending side branches. Gonads developed upon side branches of radial-canals. Exumbrella with longitudinal ridges.

The hydroid is closely related to *Campanularia*, but the blastostyles do not produce sessile sporosacs, but give rise to free medusæ. The blastostyle of *Eucopella* exhibits 4 radial tubes between which the medusa-buds are developed.

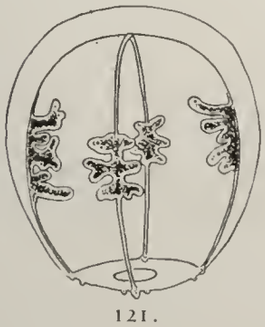
The medusæ of *Eucopella* are comparable in their degeneracy to *Agastra*, but in *Agastra* we find rudimentary tentacle-bulbs, whereas even these are absent in *Eucopella*.

The hydroid described by Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 569, fig. R 1, as *Eucopella reticulata*, appears not to produce free medusæ and belongs therefore to the genus *Campanularia*.

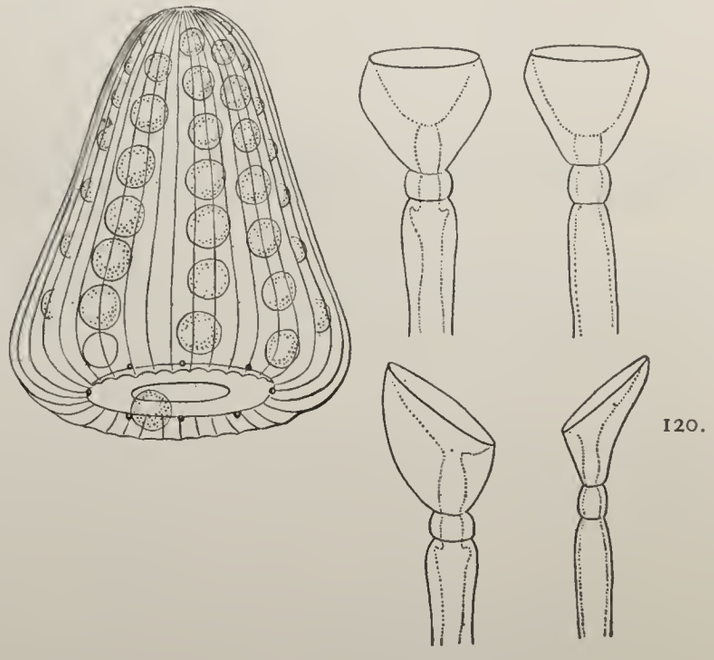
Eucopella bilabiata.

Campanularia bilabiata, Coughtrey, 1875, Trans. New Zealand Institute, vol. 7, p. 293, plate 20, fig. 45 (hydroid).
Campanularia compressa, Clarke, 1876, Proc. Acad. Nat. Sci. Philadelphia, p. 214 (hydroid only).
Eucopella campanularia, von Lendenfeld, 1883, Zool. Anzeiger, Jahrg. 6, p. 186; 1883, Zeit. für wissen. Zool., Bd. 38, p. 497, taf. 27–32, 37 fign. (hydroid and medusa).—Bale, 1888, Proc. Linnean Soc. New South Wales, ser. 2, vol. 3, p. 751, plate 13, figs. 9–15.
(?) *Clytia compressa*, Nutting, 1901, Proc. Washington Acad. Sci., vol. 3, p. 170, plate 17, figs. 3, 4 (hydroid from Alaska).—Torrey, 1902, University of California Publications, Zool., vol. 1, p. 58, plate 6, fig. 49 (hydroid from California).

Medusa.—Bell pyriform, 1.5 mm. high; walls thin, thinnest at rounded apex. 30 to 40 meridional ridges extend up exumbrella from velar margin to near apex; these are especially prominent when the medusa contracts. Each ridge is said to be composed of a strand of meridional "nerve-fibers," which branch off from the outer nerve-ring at the bell-margin. There are 8 adradial lithocysts, each with a single concretion. No trace of tentacles. Velum is well-developed. Ring-canal narrow. The 4 radial-canals extend from the ring-canal to near bell-apex, before reaching which they are closed and obliterated. They give rise to numerous side branches between the gonads. There is no manubrium. The ripe ova are found in two rows in the entoderm on both sides of the radial-canals between the side branches of the canals. The spermaries are ectodermal and occur in 4 large, longitudinal swellings over the 4 radial-canals. The bell-cavity is almost filled with the genital organs. The medusa is colorless except the entoderm of the 4 radial-canals, which is brown. It lives but a few hours and soon discharges its genital products.



121.



120.

Fig. 120.—*Eucopella bilabiata*, after von Lendenfeld, in Zeit. für wissen. Zool. Showing ripe medusa and forms of hydrothecæ.
Fig. 121.—*Agastra mira*, after Browne, in Proc. Zool. Soc. London.

Hydroid is a Campanularian. The stems are simple, unbranched, 4 to 6 mm. high, and arise singly from a hydrorhiza which forms an open network over *Laminaria*. The stems are smooth, with one or two ring-like constrictions at base of hydrothecæ. Hydrotheca bell-shaped and constricted at its upper, open end. The lip is simple and entire, without serrations. The polypite is elongate, spindle-shaped, with a flaring mouth and a single zone of 32 filiform tentacles. The base of the polypite at bottom of hydrotheca is wide.

The gonophores are placed upon short unringed pedicels and attain a height of 2 to 3 mm. They are laterally flattened and elliptical in cross-section. The gonophore develops two medusa-buds, one small (lower) proximal and one large (upper) distal medusa. When the upper one is discharged the lower one develops so as to fill the lower half of the gonophore. The female germ-cells are entodermal and develop in the cœnosarc of the hydrorhiza and finally migrate into the entodermal linings of the side branches of the radial-canals of the medusa. The sperm is ectodermal and develops over the radial-canals of the medusa-buds. The ento-

derm of the stomach of the polypites and of the radial-canals of medusa-buds contains brown pigment-granules. Von Lendenfeld describes a "nerve-ring" of entodermal cells in the proboscis of the hydroid near the mouth. There is no proof, however, that this plexus is actually a nerve-ring.

Common on the southern coasts of Australia. Described in detail by von Lendenfeld, 1883 (Zeit. für wissen. Zool., Bd. 38, p. 497). This form is probably identical with Coughtrey's *Campanularia bilabiata* from the coast of New Zealand; and appears also to be identical with *C. compressa* described by Clarke, 1873, and Nutting, 1901, from the coast of Alaska.

Eucopella crenata Hartlaub.

Eucopella crenata, Hartlaub, 1901, Zoolog. Jahrb., Syst. Abth., Bd. 14, p. 364, taf. 22, fign. 27–31, 33–35.

Hydrorhiza a wide network, hydranths about 5 mm. high; variable. Stems are thick. Hydrotheca with 12 to 14 teeth. Body of hydranth larger than hydrotheca. Gonotheca large, wide, and short, arises by a short stalk from the hydrorhiza. Two medusæ in gonotheca, in different stages of development. The medusæ contain the sex-cells before liberation.

Found at French Pass, New Zealand.

This form appears to me to be a close variety of or even identical with *Eucopella bilabiata* Coughtrey=*E. campanularia* von Lendenfeld=(?) *Campanularia caliculata* var. *macrogona*.

Genus AGASTRA Hartlaub, 1897.

Agastra, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommiss. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 504.

The type species is *Agastra mira* Hartlaub, of Helgoland and the British coast.

GENERIC CHARACTERS.

Eucopidæ without manubrium and without tentacles. 8 adradial lithocysts. 4 simple, unbranched radial-canals. 4 sac-like, lobular gonads, 1 upon each radial-canal. Exumbrella smooth and without longitudinal furrows. The hydroid appears to be *Campanularia*.

Agastra mira Hartlaub.

A leptomedusa, Browne, 1897, Proc. Zool. Soc. London, p. 832, plate 49, figs. 3, 3*a*.
Agastra mira, Hartlaub, 1897, Wissen. Meeresuntersuch. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 504, taf. 22, fign. 8–10; 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 561.—Browne, 1898, Proc. Zool. Soc. London for 1897, p. 832, plate 49, figs. 3, 3*a*.
Campanularia caliculata, Hincks (hydroid), see Giard, 1898, Comp. Rend. Soc. Biol. Paris, sér. 10, tom. 5, p. 17.
Agastra caliculata, Delap, M. and C., 1905, Annual Report Fisheries of Ireland, 1902–03, Part 2, App. 4, p. 11.

Medusa.—Bell somewhat higher than wide, 1 mm. high, with scattered isolated nematocysts over exumbrella. Gelatinous substance quite thick and of equal thickness everywhere except at the apex, where there is a deep, narrow, funnel-shaped depression. No tentacles, but 4 minute, pigmented bulbs. 8 adradial lithocysts, each with a single concretion. 4 narrow radial-canals and a ring-canal. No stomach, the radial-canals either ending blindly at inner apex of bell-cavity or fusing at one point at this place. The gonads are elongate, irregularly arranged, sac-shaped evaginations upon both sides of the middle parts of each radial-canal. The ripe eggs are in the entoderm. The ring-canal, radial-canals, "tentacle-bulbs," and gonads display many dark-brown granules. Hydroid unknown. Found off the English and German Atlantic coasts. August to October. (See text-figure 121.)

According to Giard, 1898, *Campanularia caliculata* Hincks is the hydroid of *Agastra mira*. Giard states that this hydroid sometimes produces free medusæ (*Agastra mira*), although usually its gonophores are sessile, and that in running water the hydroid produces sterile stolons, which become fertile in still water.

Genus EUCOPE Gegenbaur, 1856 (sens. emend.).

Eucope (in part), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 241.
Non Eucope, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351.—Agassiz, A., 1865, North Amer. Acalephæ, p. 83.
Saphenella+Eucopium+Eucope, Haeckel, 1879, Syst. der Medusen, pp. 168, 169, 170.
Phialella, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 282.
Eucope, Keferstein und Ehlers, 1861, Zoolog. Beitrag., p. 88.—von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 920.
Non Eucope, Agassiz, A., and Woodworth, 1896, Bull. Museum Comp. Zool. at Harvard College, vol. 30, p. 121.
Campanulina, Hincks (hydroid), 1868, Hist. British Hydroid Zooph., p. 186.

GENERIC CHARACTERS.

Eucopidæ with 8 adradial lithocysts and 4 sac-like gonads, one on each of the 4 simple radial-canals. Without marginal cirri. Manubrium without a peduncle. With 2 or more tentacles which lack basal projections extending into the gelatinous substance of the bell. No marginal eye-spots. The hydroid is *Campanulina* Van Beneden.

The medusæ of *Eucope* are readily distinguished from *Obelia* by the fact that in *Eucope* the tentacle-bases are simple and hollow, and the entodermal cores of the tentacles *do not* project inward into the gelatinous substance of the bell as in *Obelia*.

As the number of tentacles varies greatly in the different species which are otherwise closely related, it seems convenient to group them all under the generic name of *Eucope*. Haeckel, however, proposes the designation *Saphenella* for medusæ with 2 diametrically opposed perradial tentacles; and *Eucopium* for medusæ with 4 tentacles; while his *Eucope* applies to medusæ with 8 or more tentacles. Inasmuch as the number of tentacles probably increases with age it affords a poor criterion for the separation of genera and may better be regarded as of specific rather than of generic value. I have therefore included Haeckel's three genera under the oldest name "*Eucope*."

The medusæ described by Gegenbaur under the generic designation *Eucope* are probably young stages of *Clytia*, and mature ones of *Obelia*, and stages in the growth of *Phialidium*. Thus Gegenbaur's "*Eucope*" *campanulata* and *E. affinis* appear to be young stages of *Clytia volubilis*. His *E. thaumantiodes* is probably a young *Phialidium* and his *E. polystyla* is an *Obelia*.

The oldest described *Eucope*, in the present sense of the definition of the genus, is *E. globosa*=*Thaumantias quadrata*, etc., Forbes, from the British coasts.

Eucope globosa.

Thaumantias quadrata, Forbes (young medusa), 1848, British Naked-eyed Medusæ, p. 43, plate 9, fig. 2; *Ibid.*, *T. æronautica*, p. 44, plate 9, fig. 3; *T. octona*, p. 44, plate 8, fig. 4; *T. maculata*, p. 45, plate 9, fig. 4; *T. globosa* (mature medusa), p. 46, plate 10, fig. 4.

Thaumantias cymbaloides, Van Beneden, 1866, Mém. Acad. Royal Belgique, tome 36, p. 88.

Campanulina repens (hydroid and young medusa), Hincks, 1868, Hist. British Hydroid Zoophytes, p. 189, plate 38, figs. 1, 1*a*.

Tetranema aeronauticum=*Phialidium variabile* (in part), Haeckel, 1879, Syst. der Medusen, pp. 125, 186.

Thaumantias globosa, Haddon, 1887, Sci. Proc. Royal Dublin Soc., p. 476, plate 11, fig. 1 (medusa infected with parasitic *Halcampa*).

Phialidium cymbaloideum, Browne, 1896, Proc. Zool. Soc. London, p. 491, plate 17, figs. 1–2*a*; 1905, Proc. Roy. Soc. Edinburgh, vol. 25, p. 771.

Forbes, 1848, described this medusa under several names, the first name applied to it being *Thaumantias quadrata* to indicate its young, 4-tentacled stage. The name applied by Forbes to the adult was *T. globosa*. "*Quadrata*" takes precedence over this, being mentioned on page 43, while "*globosa*" occurs on page 46, but the specific name must be *globosa*, this being the first one applied to the adult medusa.

Browne shows that the following described by Forbes are probably only stages in the growth of this medusa: *Thaumantias quadrata*, having 4 tentacles; *T. æronautica*, 4 tentacles; *T. octona*, 8 tentacles; *T. maculata*, 16 tentacles; *T. globosa*, 32 tentacles.

The adult medusa may be described as follows: Bell thick-walled, fuller and slightly higher than a hemisphere. About 13 mm. wide. 32 or more short tentacles, not half as long as bell-diameter. 8 adradial lithocysts, each with 3 to 8 concretions. No cirri. 4 short, linear gonads, beyond middle points of the 4 straight, slender radial-canals. Manubrium short, with 4 simple recurved lips. No peduncle. Manubrium and gonads yellowish to reddish-brown. Common off the British coasts and the coast of Holland.

Browne described the early stages of this medusa. When 1.5 mm. high and 1 mm. wide, there are 4 perradial tentacles, 4 interradial tentacle-bulbs, and 8 adradial lithocysts each with 2 or 3 concretions. The 4 gonads appear as 4 small oval swellings at middle points of the 4 radial-canals.

Hydroid.—Browne discovered the hydroid of this species at Plymouth, England. It was described by Hincks, 1868, as *Campanulina repens*. The stems arise from a creeping hydrorhiza and are ringed throughout; they branch sparingly and somewhat irregularly in a more or less alternate manner; several branches sometimes arise from the stem close together. The

hydrothecæ are conical, with the opening closed by an operculum formed of acute, triangular, convergent teeth, which may open or close the opening. The polypites are very extensible and have about 16 tentacles alternately elevated and depressed, and united at their bases by a very shallow web. Gonothecæ large and may arise singly from the hydrorhiza or from the stem. They are oblong, club-shaped, and slightly gibbous at one side near base. When set free, the medusa has 4 tentacles. Height of hydroid (?) It invests the surface of Sertularian hydroids.

Eucope picta Keferstein and Ehlers.

Eucope picta, Keferstein und Ehlers, 1861, Zoolog. Beitrag., p. 88, taf. 13, fign. 11, 12.
Eucopium pictum + *Eucopium primordiale*, Haeckel, 1879, Syst. der Medusen, p. 168, taf. 11, fign. 1–3.

Bell globular, rounded, or hemispherical, about 1 mm. wide. 4 radially placed tentacles with well-developed, conical basal bulbs. 8 adradial lithocysts, each with a single concretion. 4 slender radial-canals. Velum well-developed. Manubrium 4-sided, one-fourth to half as long as depth of bell-cavity. 4 sac-like gonads from middle to upper thirds of the 4 radial-canals.

Tentacle-bulbs, stomach, and gonads yellowish or brownish-yellow.

Found at Messina and Corsica, Mediterranean.

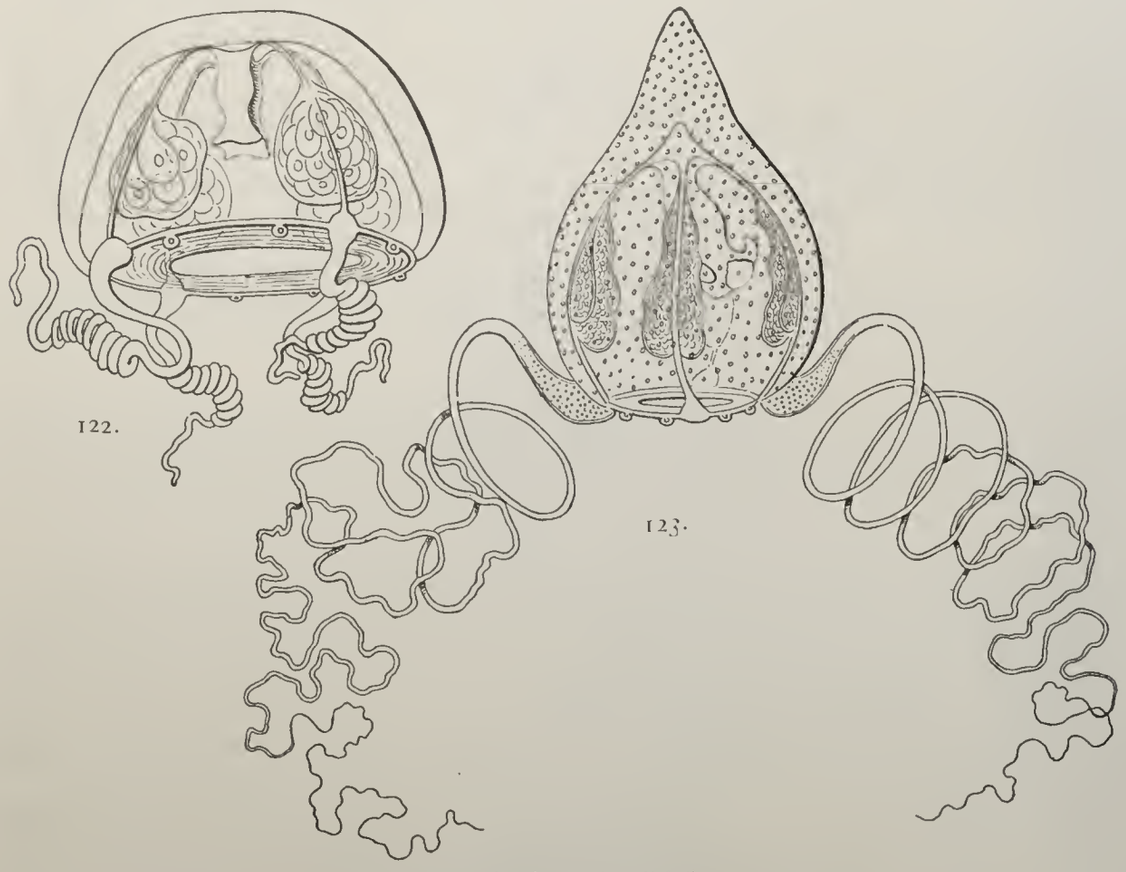


Fig. 122.—*Eucope picta* ("*E. primordiale*").
Fig. 123.—*Eucope dissonema* ("*Saphenella dissonema*").
Above figures after Haeckel, 1879.

Haeckel considers his *Eucopium primordiale* to be distinct from *Eucope picta* of Keferstein and Ehlers, basing his distinction upon its larger gonads, flatter bell, and longer tentacles, but the general resemblance between the two forms is so close that I am inclined to consider them one and the same species in somewhat different stages of development. Haeckel obtained his medusæ from a Clytia-like hydroid resembling *Clytia johnstoni*. The goblet-shaped, ringed gonangia arise between the hydranths from a creeping hydrorhiza, and each gonangium contains 8 to 12 medusæ. The hydranths are mounted upon long pedicels. Haeckel proposes to call this hydroid *Clytia "eucophora,"* but its specific name should be identical with that of its medusa.

Eucope dissonema.

Saphenella dissonema, Haeckel, 1879, Syst. der Medusen, p. 169, taf. 11, fig. 5.

Bell pyriform, with pointed apex, 5 mm. wide, 7 mm. high. The exumbrella is thickly besprinkled with nematocysts. This may be an indication of immaturity (?) Two radially placed tentacles 180° apart. These have large, pyriform, basal bulbs and long, slender, tapering shafts. 8 adradial lithocysts, each with a single concretion. Velum well-developed. 4 slender radial-canals. Manubrium spindle-shaped, about half as long as depth of bell-cavity, and provided with 4 short recurved lips. Gonads sac-like, folded, and upon middle halves of the 4 radial-canals. There is a short, conical, apical canal above stomach. Color (?) Development (?) Pacific Ocean, near the Hawaiian Islands. (See text-figure 123.)

Eucope hyalina von Lendenfeld.

Eucope hyalina, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 920, plate 42, figs. 16–18.

Bell flat, watch-glass-shaped, 6 mm. wide. Gelatinous substance thick at center. 8 tentacles with conical basal bulbs, about as long as half the bell-diameter. 8 large adradial lithocysts, each with 3 concretions. Lithocysts spherical and mounted upon sensory pads which bear hair-like bristles. 4 large oval gonads on distal thirds of the 4 radial-canals, near ring-canal. Stomach half as long as bell-radius and wider than long. Gonads and stomach pale yellow, other parts colorless. Found in Sydney Harbor, New South Wales, Australia, in September.

Eucope annulata von Lendenfeld.

Eucope annulata, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 602, plate 28, figs. 53–57.

Medusa.—Bell ovate, evenly rounded, 2.5 mm. high, 2 mm. wide. 8 short, thick tentacles one-third as long as bell-height. Basal bulbs small and without entodermal cores projecting into gelatinous substance of bell. 8 large, adradial lithocysts, each usually containing 2 concretions. Velum well-developed. 4 straight, wide radial-canals. Manubrium 4-sided, prismatic, with a slight constriction in lower third; wide at mouth with 4 simple lips, narrow at base. 4 oval gonads on distal thirds of the 4 radial-canals. Each gonad about one-fourth as long as radial-canal upon which it is placed. Gonads yellow, other parts colorless.

Irregular medusæ with 5 radial-canals, produced by the forking of one of the main radial-canals, are common.

Hydroid.—Stems 12 to 16 mm. high and arise from a creeping, reticulate, anastomosing hydrorhiza. Stems are profusely and irregularly branched, the branches diverging at acute angles, so that the general outline of the colony is pyramidal. The branches are annulated throughout, the annulations being deeper near base than at ends of stems. The hydrothecæ thin, conical, and with simple, entire, unnotched lips. The hydranths have a single verticil of 30 to 35 filiform tentacles and a wide mouth at the extremity of a flaring neck. The gonothecæ are club-shaped, elongate, with rounded outer ends, and are produced at or near the axils of the stems. They have no annulated pedicels. Many medusæ are produced in each gonangium. Perisarc light-brown. Entoderm of gonophores light and dark-brown.

Found on the coast of New Zealand, at Lyttleton. Medusæ produced in June and July.

Eucope falklandica.

Phialella falklandica, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 282.

Bell 17 mm. wide and 11 mm. high, semiglobular, with thick walls. 60 to 70 tentacles with large basal bulbs. 8 adradial sense-organs, each with 2 or more concretions. Stomach short and quadrangular. Mouth with 4 lips with fringed margin. Gonads occupy nearly the whole length of the 4 radial-canals. They hang down in wavy folds, not touching either bell-margin or stomach. Found at Stanley Harbor, Falkland Islands, by Vallentin, and described by Browne, who studied 8 specimens.

Eucope parvigastra.

Plate 31, fig. 5.

Eucopium parvigastrum, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 52, plate 42, fig. 140.

Bell half-egg-shaped, 1 mm. high, with small, dome-like, apical projection. 4 small, radially situated tentacles, hardly more than mere tentacle-bulbs. 8 lithocysts, 2 in each quadrant, each containing a single spherical concretion. Velum well developed. 4 straight, narrow radial-canals and a slender circular vessel. Manubrium very small, a mere tube, cruciform in cross-section, and provided with 4 simple lips. The gonads occupy 4 linear swollen regions near the middle of the 4 radial-canals. Entoderm of tentacle-bulbs, gonads, and manubrium of a decided brown color.

This medusa was quite common at Tortugas, Florida, late in June, 1899. It is distinguished from other species of *Eucope* by its very small manubrium, and in this respect it appears to foreshadow the condition seen in *Agastra*, wherein manubrium has entirely disappeared. Development unknown.

Genus OBELIA Péron and Lesueur, 1809.

Medusa marina, Slabber, 1781, Physikalischen Belustigungen, p. 40, taf. 9, fign. 5-8.
Obelia, Péron et Lesueur, 1809, Tableau des Méduses, etc., Ann. Mus. Hist. Nat. Paris, tome 14, p. 355.—McCrady. 1857, Gymn. Charleston Harbor, p. 94.—Allman, 1864, Ann. and Mag. Nat. Hist., ser. 3, vol. 13, p. 372.—Hincks, 1868, British Hydroid Zoophytes, p. 146.—Kowalevsky, 1873, Mém. Imp. Soc. Friends of Nat. Hist., vol. 10, Part 2, Moscow (development).—Haeckel, 1879, Syst. der Medusen, p. 171.—Hartlaub, 1894, Cœlenteraten Helgolands, p. 171.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 349; Proc. Washington Acad. Sci., vol. 3, p. 173.—Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. p. 580.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 457; *Ibid.*, tome 13, p. 95 (list of papers).
Laomedea, Lamouroux, 1812, Nouv. Bull. Sci. Soc. Philomantique, tome 3, p. 184, Paris.
Obelia, de Blainville, 1834, Manuel d'Actinologie, p. 281, Paris.
Thaumantias (in part), Forbes, 1848, British Naked-eyed Medusæ, p. 41.
Eucope (in part), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, Heft 2, p. 241.
Obelia+*Eucope*, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351.—Agassiz, A., 1865, North American Acalephæ, pp. 83, 91.
Obelia+*Schizocladium*, Allman, 1871, Browne, E. T., 1906, Quart. Journ. Microscop. Sci., vol. 50, p. 645; Allman, *Ibid.*, 1871, vol. 11, p. 18.
Eucope, Agassiz and Woodworth, 1896, Bull. Museum Comp. Zool. at Harvard College, vol. 30, p. 121.

The genus *Obelia* was founded by Péron and Lesueur, 1809, for a form which had been described by Slabber under the name of *Medusa marina*. This medusa conforms in all respects to the characters of the genus *Obelia* as we here define it. The genus *Thaumantias* as defined by Forbes, 1848, includes *Phialidium* as well as *Obelia*, and this is true also of *Eucope* as defined by Gegenbaur, 1856. The name "*Obelia*" was restored by McCrady, 1857, for *Obelia commissuralis*.

GENERIC CHARACTERS.

Eucopidæ with numerous tentacles. The 4 sac-like gonads are upon the 4 radial-canals. There is no peduncle. Tentacles peculiar in that their axial entoderm projects inward from margin into the gelatinous substance of the bell. The 8 vesicular, adradial lithocysts are borne upon under side of basal bulbs of 8 of the tentacles.

This genus is readily distinguished from *Phialidium* and from *Clytia* by the fact that in *Obelia* there are but 8 lithocysts, 2 in each quadrant. Moreover, in *Obelia* the tentacle-bulbs project inward into the gelatinous substance of the bell, whereas in *Clytia* and *Phialidium* this is not the case.

Obelia is also distinguished from *Tiaropsis* L. Agassiz by the absence of marginal eye-spots and by its simple, closed lithocysts. The lithocysts in *Obelia* usually contain a single concretion instead of many, as in *Tiaropsis*. It is distinguished from *Eucheilota* by the absence of lateral cirri at the sides of the tentacles, and from both by its inwardly projecting tentacle-cores.

Mature medusæ of *Obelia*, all possessing 8 marginal lithocysts and a large and variable number of tentacles, are exceedingly common along the New England coast from April until the last week of November. Owing to the similarity in size and appearance of the mature medusæ, one would be led to believe that they all belonged to one and the same species. Upon examination of the hydroid stocks, however, differences that may be of specific value are

brought to light; yet some of these differences in the hydroids and young medusæ are not of specific value, but are probably due to the influence of environment upon the individual, such as favorable or unfavorable conditions of growth, geographical situation, depth and temperature of water, light, etc. It is also true that some of the observed differences in the hydroid stocks are probably of good specific value, and that we have in *Obelia* a genus in which the mature medusæ of the various species closely resemble one another, while fairly well-defined differences exist in the hydroids and young medusæ. It is quite true, however, that the young medusæ of one and the same species, at the time of liberation from the reproductive calycles, vary considerably both in the number of tentacles which they possess and in the state of development of the gonads. The study of every fairly large collection of these hydroids seems to have led only to the burdensome addition of "new" species founded upon minute distinctions.

Undoubtedly many "species" have been founded on mere geographical or environmental characters of a racial rather than specific nature, and hopeless confusion has long since been introduced into the synonymy. The following description of the so-called species is presented mainly with the hope that an inspection of the inextricable confusion here displayed may deter future students from further inflictions of such "discoveries" upon the world. Every bushel basket full of *Obelia* hydroids, collected at random along our shore, is sure to contain several dozens of "new species."

Species of *Obelia* are widely distributed along the shores of the temperate oceans, but they are rare in tropical regions. The rich growth of kelps and fucus along the rocky shores of temperate regions affords abundant anchorage for the hydroids of *Obelia*, but in the tropics large seaweeds are absent in shallow water, and this fact may account for the rarity of *Obelia* in warm oceans. Many of the species are of very wide distribution, being found in the Atlantic and the Pacific and in the northern as well as the southern hemispheres. They are all littoral forms, and the medusæ are not found far from coasts.

De Varenne, 1883, and Weismann, 1883, find that the sex-cells of *Obelia* originate in the entoderm of the stem of the hydroid and later migrate into the medusa-bud, pushing through the entoderm into the ectoderm, which finally incases them. Interesting studies of the wanderings of the developing sex-cells in the medusa have been conducted by Hartlaub and are referred to in detail in the description of *O. adelungi* and *O. helgolandica*.

The macroscopic details of development of *Obelia* have long been known. In 1883, Méreschkowsky found that the entoderm arises from cells which wander singly into the interior from the posterior end of the pear-shaped planula larva. (See Bull. Soc. Zool. de France, tome 1883, 8, p. 98.)

Regeneration in *Obelia* has been studied by Davenport, 1894 (Anatomischer Anzeiger, Bd. 9, p. 283). He finds that the regenerative tissue is not differentiated at different places to produce different things, independent of environment; but on the contrary, the embryonic tissue at all levels may produce the same things. Moreover, there is no important indication of difference in the germ-plasma at different levels in respect to the size or form of the parts which regenerate. The hydroids display a marked tendency to regenerate 3 to 6 or 9 to 11 rings when cut at any point on the stem.

These results of Davenport's should, however, be interpreted in connection with the extensive work of Morgan, 1905 (Journal Experimental Zoology, vol. 2, p. 495, and *ibid.*, 1906, vol. 3, p. 501). Morgan finds that *Tubularia* displays a definitely recognizable although not absolute polarity. A stolon is very rarely, and a hydranth commonly, regenerated upon the stem if it is cut across near the terminal hydranth, whereas a stolon is often regenerated from the aboral end of the stem if cut across near the lower end of the stem. The aboral end of a cut-off piece of stem may, however, be caused to regenerate a hydranth if the oral end, near the base of the polypite, be tied with a ligature, as was first shown by Loeb. Loeb concluded that the polarity in the whole stem was reversed by this process of tying a ligature, but Morgan refutes this idea and shows that the effect is confined to the aboral end itself which is regenerating a polypite. Morgan concludes "that a gradation of hydranth-forming substance is present in the stem of *Tubularia*, and that the amount present at any level determines the rate at which both the oral and basal hydranth develop." He also concludes that "the farther the level of the stem from the hydranth the greater its differentiation as stem; hence its gradation of

differentiated materials, and hence the longer road it must retrace to produce another structure, the hydranth." There are many interesting facts and hypotheses in Morgan's paper which would not be pertinent to this brief discussion. See also, Child, 1907, Archiv. Entwick.-Mech. Organismen, Bdn. 23, 24. *Tubularia* with its long, sparingly branched stems and isolated, terminal polypites is naturally a more favorable object for such studies than is *Obelia*, hence the discrepancies in the results attained by Davenport and by Morgan.

General Characters of the So-called Species of Obelia.

	O. gelatinosa Hincks.	O. commissuralis McCrady.	O. dichotoma Hincks.	O. australis von Lendenfeld.*	O. pyriformis Verrill.	O. dubia Nutting.	O. striata Clarke.
Height of colony in mm.	100 to 250	125 to 150	75 to 150	3 to 37	75 to 125	20	(?)
Character of branching.	Tree-like, thickly branched. Branches arise in pairs at short intervals, and are placed alternately on opposite sides of stem.	Tree-like. Long main stem sparsely branched. Side branches spring out at right angles to main stem.	Tree-like, irregularly branched.	Stem creeping, adnate to foreign bodies. Branches 3 to 4 mm. long, or tree-like, 35 to 37 mm. high, sparingly, alternately branched.	Tree-like, without knees or breaks in uniformity of stem.	Main stem sinuous, sparingly branched, giving off pedicels at bends.	Stems simple, arising from creeping stolon. Hydrothecæ alternate.
Shape of hydrothecæ.	Small, thin-walled, smooth, and conical.	1.5 times as long as wide.	Long, nearly conical, but with slightly bulging sides.	(?)	Short and flaring.	Very large, tubular, with longitudinal ribs near margin.	Tapering to base. 14 to 16 longitudinal striations.
Character of margins of hydrothecæ.	Cut into deep denticles of castellated form, slightly hollowed at top.	Smooth and circular.	Slightly sinuous.	(?)	Smooth.	Very shallow undulations.	14 to 16 teeth projecting inward.
Character of pedicels of hydrothecæ.	Short, with several rings.	Ringed at both ends, about as long as intervals between internodes of branches.	Often ringed throughout with 4 to 16 rings.	Short, annulated.	Long, with 12 to 15 rings.	Long and annulated throughout.	Ringed at both ends.
Shape of gonothecæ.	Small, ovate to club-shaped. Widest at upper end.	Slender, conical, with short neck at broad upper end.	Long, conical, with smooth outer surface.	Elongate.	Very variable in shape. When full-grown they are usually elongate ellipsoid, with a pointed distal end.	Unknown.	Nearly cylindrical, tapering to base. Curved.
Character of medusa at liberation.	With about 24 tentacles.	16 tentacles and no gonads.	16 to 24 tentacles, and with 4 gonads adjacent to manubrium.	24 tentacles. Like medusa of O. geniculata.	24 tentacles, 4 gonads near manubrium.	(?)	4 tentacles.
Where found.	Atlantic coasts of Europe. In America from Cape Cod to the Carolinas. Mediterranean.	Atlantic and Pacific coasts of North America.	Along shores of temperate regions of Atlantic and Pacific.	Australia and New Zealand.	Atlantic coast of United States.	Alaska.	Tropical Pacific.

*Probably a variety of *O. dichotoma*. Description inadequate.

The variations of the medusæ of *Obelia* have been made the subject of elaborate study by Agassiz and Woodworth, 1896 (Bulletin Museum Comp. Zool. at Harvard College, vol. 30, p. 121, 9 plates). These authors obtained the medusæ in surface-tows made at Newport,

General Characters of the So-called Species of Obelia—Continued.

	O. hyalina Clarke.	O. plana Haeckel=O. flabellata Hincks.	O. borealis Nutting.	O. geniculata Allman.	O. griffini Calkins.*	O. surcularis Calkins.†	O. gracilis Calkins.‡
Height of colony in mm.	12	200	440	About 25 high, arising from long, creeping stolon.	25 to 50	25. Arising from creeping hydrorhiza.	Stems 6 to 20 high, arising from creeping hydrorhiza.
Character of branching.	Stems arise from creeping stolon. Stems only slightly branched.	Filiform, somewhat zigzag, much annulated. Short alternate branches, which branch more or less dichotomously.	Long, slender, sinuous, with paired branches on proximal part, and singly on upper part of stem. Branching usually verticillate.	Zigzag main stems, rarely branched. Stem ringed at flexures, and thickened immediately below them.	Profusely branched with branches regularly alternate, about 0.5 mm. apart.	Erect, isolated, arising from a creeping hydrorhiza. Branches regularly alternate, generally ending in filiform tendrils.	Stem slightly zigzag, slightly branched. Hydrothecæ alternate with 2 hydrothecæ at each angle of stem.
Shape of hydrothecæ.	Short, tapering toward base. Intrathecal partition near base.	Short, conical, widely flaring.	Funnel-shaped, straight sides.	Short, about as wide as long. Conical, with slightly bulging sides.	Deep, with curved sides flaring outward at orifice. 0.25 to 0.35 mm. long, with a simple diaphragm.	Swollen at center, with an everted margin. 0.3 mm. long, 0.25 mm. wide.	Long-stalked hydrothecæ 0.36 mm. long and 0.32 mm. wide, while short-stalked ones are only 0.32 mm. long and 0.19 mm. wide. Diaphragm double.
Character of margins of hydrothecæ	Entire and smooth.	Entire.	Entire and smooth.	Entire and smooth.	Plain.	Smooth.	Plain.
Character of pedicels of hydrothecæ.	Usually annulated at both ends, occasionally throughout.	Tapering and completely ringed with 3 to 10 rings.	Pedicels set on broad shoulders of stem. Short and wholly annulated, or long and ringed at both ends.	Short, with 4 to 6 rings. Inclined at an angle of 30° with main stem.	Ringed throughout with about 9 rings. 0.1 mm. long.	Tapering from base to end and ringed throughout.	Long ones annulated at both ends, but short ones which arise in axils of former are annulated throughout.
Shape of gonothecæ.	Small, only twice as long as hydrothecæ. Tapering toward base and rounded off at distal end.	Ovate to club-shaped, somewhat flattened at outer end.	Oblong, ovate, truncated above, with collar.	Club-shaped, widest at outer end, with short tubular orifice.	Nearly uniform in width. 0.8 to 1 mm. long, 0.25 to 0.3 mm. wide.	Rapidly expanding from base to outer end. 0.75 to 0.9 mm. long, 0.15 mm. wide.	Club-shaped, widest at outer end. 0.75 mm. long, 0.26 mm. wide.
Character of medusa at liberation.	(?)	24 tentacles, 4 gonads at middle of radial-canals.	(?)	16 to 24 tentacles. Gonads close by sides of stomach.	24 tentacles.	24 tentacles.	About 28 tentacles.
Where found.	Bermuda, Zoblos Island.	North Atlantic coasts of Europe and America.	Alaska.	World-wide distribution.	Puget Sound, Pacific coast of North America.	On eelgrass, Puget Sound, Pacific coast of North America.	On grasses at Puget Sound, Pacific coast of North America.

*O. *fragilis* Calkins resembles this species, but hydrocaulus is creeping, never erect, and margins of pedicels sinuous.
†Distinguished by its numerous tendrils at ends of branches. Probably a variety of *O. geniculata*.
‡Probably a variety of *O. geniculata*.

Rhode Island; and it is probable that several species are represented in the collection. The following is a summary of the principal results: Among 3,917 specimens, 9 had 3 radial-canals, 20 had 5, and 3 had 6 canals. In 14 specimens one of the radial-canals forked. 3,871 had 4 radial-canals. In other words, 98.8 per cent had 4 canals, 0.51 per cent had 5, 0.22 per cent had 3, 0.076 per cent had 6 canals, and 0.35 per cent had forked canals. It is remarkable that there were no variations in the lips, these being 4 in number in every specimen examined. On the other hand, the tentacles were very variable in number, and in 14 specimens they were forked or gave rise to basal spurs resembling those of *Laodicea*, etc. The egg or sperm seemed to develop to maturity with normal frequency even in abnormal specimens with 3, 5, or 6 canals. They also found that in *Obelia* the tendency to produce medusæ with 5 radial-canals is about twice as great as that to give rise to individuals with 3

General Characters of the So-called Species of Obelia—Continued.

	O. corona Torrey.*	O. helgolandica Hartlaub.	O. adelungi Hartlaub.	O. bidentata Clarke.	O. longissima Hincks.	O. chinensis Marktanner-Turneretscher.†	O. plicata Hincks.
Height of colony in mm.	As in O. gracilis.	100 to 110	80 to 100	80	300	100	15 to 20
Character of branching.	Simple, unbranched, slightly flexuous.	Stems zigzag, with short alternate side branches. Side branches have alternate ramuli.	Dense tree-like thick-stemmed. Main branches alternate, ultimate branching irregular.	Straight, irregularly branched main stems.	Tapering, slightly zigzag. Branches arise alternately on opposite sides of main stem. Branches branch also in a manner similar to main stem.	Zigzag, sparingly branched.	Coarse, tree-like, thick at base, thin at tips. Dense bundle of branches irregularly arranged, but more or less alternate.
Shape of hydrothecæ.	Long, narrow, tapering, 0.43 long to 0.19 wide.	Large. 0.5 mm. long. Conical.	Conical. 0.5 long.	Deep, tubular, with 8 to 10 longitudinal ribs between teeth.	Campanulate, large, delicate, elongate, nearly conical, with slightly bulging sides.	Bell-shaped. 0.5 long, 0.35 wide.	Conical, wide.
Character of margins of hydrothecæ.	8 to 10 teeth, each with 2 sharp cusps.	Smooth, plain.	Plain.	With 8 to 10 bimucronate teeth.	Delicately notched with small blunt teeth.	Plain.	Plain.
Character of pedicels of hydrothecæ.	Short with 2 to 4 rings.	0.8 mm. long, and ringed throughout.	0.8 long, and ringed throughout.	With 10 to 15 rings, annulated throughout.	Long, ringed throughout with 8 to 15 annulations.	Ringed at both ends, 0.5 to 0.9 long.	Ringed throughout, 4 to 12 rings.
Shape of gonothecæ.	Club-shaped, with wide aperture. 0.76 mm. long, 0.2 mm. wide.	Often curved. 1 mm. long.	Elongate conical.	(?)	Ovate to conical, orifice crater-shaped.	(?)	(?)
Character of medusa at liberation.	24 tentacles.	24 tentacles. Gonads upon manubrium.	24 tentacles. Gonads upon manubrium.	(?)	20 to 24 tentacles.	(?)	(?)
Where found.	San Diego Bay, California.	At great depths off Helgoland, German Ocean.	At great depths off Helgoland, German Ocean.	Long Island Sound, Atlantic coast of North America. Malay Archipelago.	World-wide distribution.	Yellow Sea, coast of China.	Shetland Isles, coast of Great Britain. Puget Sound to Alaska. Pacific coast, North America.

*Probably a variety of *O. geniculata* with toothed margins to the hydrothecæ.
†Probably identical with *O. plana*.

or 6 canals. Yet medusæ of *Obelia* with 5 canals have not succeeded in perpetuating a new 5-rayed species.

Herbst, 1904, Archiv. Entwick.-Mech., Bd. 17, pp. 306–520, finds that medusæ of *Obelia* cease to pulsate in solutions lacking sodium, calcium, or potassium, but containing all of the remaining constituents of sea-water. Pulsation returns, however, when the medusæ are replaced in normal sea-water.

When young the medusæ of *Obelia* commonly swim with bell everted, but this habit becomes less frequent, or is abandoned, in the adult. The medusæ of the several "species" are so similar each to each that they can not be distinguished apart. For this reason I have not included descriptions of *Obelia multicia* Browne, 1902 (Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 281), from the Falkland Islands. This medusa is said to have heart-shaped tentacle-bulbs, but this description might apply to nearly any one of the known forms of *Obelia* medusæ in certain states of contraction.

General Characters of the So-called Species of Obelia—Continued.

	O. arruensis Marktanner-Turneretscher.	O. serratula Bale.	O. linearis Thornely.	O. delicatula Thornely.*	O. angulosa Bale.	O. andersoni Hincks.	O. nigra Browne.†
Height of colony in mm.	50	10+	7	4. Hydrorhiza creeping.	25 to 50	(?)	
Character of branching.	Similar to O. plicata.	Branched, with stolons growing downward from peduncles of hydrothecæ.	Branched.	Simple, unbranched, arising from creeping stolon.	Simple stemmed with numerous sub-erect side branches. All more or less zigzag.	Nearly straight, with alternate pedicels.	
Shape of hydrothecæ.	Bell-shaped. 0.6 mm. long, 0.36 mm. wide.	Short, broad, flaring, conical.	Deep.	Elongate, goblet-shaped.	Funnel-shaped. Constricted at somewhat oblique diaphragm. With everted margin.	Upper three-fourths cylindrical, lower one-fourth conical. Orifice expanded.	
Character of margins of hydrothecæ.	With 14 to 18 teeth.	10 to 12 large triangular teeth.	12 blunt teeth.	12 blunt teeth.	Not toothed, but uneven.	10 to 16 high, bluntly pointed teeth.	
Character of pedicels of hydrothecæ.	Somewhat longer than in O. plicata.	Very short, cylindrical, ringed with 3 to 4 rings at upper end.	Tapering, ringed throughout. 12 to 16 rings.	Very long with 3 to 4 rings at both ends.	Short, with 3 to 5 rings, or twice as long as hydrothecæ and ringed at both ends.	Ringed throughout. 7 to 8 rings.	
Shape of gonothecæ.	Goblet-shaped, widest above. Arise in clusters from stem.	Oval, truncated above, with smooth outer surface.	Oval, elongate, smooth, with prominent orifice, recurved and gaping.	Borne on hydrorhiza. Short, blunt, with flaring margin.	Long, slender, urn-shaped, with an everted neck. 2.5 times as long as hydrothecæ.	Club-shaped, truncated above.	
Character of medusa at liberation.	(?)	(?)	(?)	(?)	(?)	(?)	Some basal bulbs of tentacles bear black or dark-brown pigment. Hydroid unknown.
Where found.	Arru Islands, tropical Pacific.	Australia, New Britain, South Pacific.	Tropical Pacific. (New Britain?)	New Britain, South Pacific.	Paramatta River, Australia.	Mergui Archipelago, off the coast of Tenasserim.	Coasts of Great Britain, Norway, and Nova Scotia.

*Distinguished by having gonothecæ arising directly from hydrorhiza.

†Torrey, 1909, describes *O. purpurea* from California, with purple tentacle-bulbs (see Appendix).

Obelia gymnophthalma Spagnolini, 1876 (Catalogo Acalefi Mediterraneo, p. 31, tav. 6, figs. 1, 2), from Naples, is probably an *Obelia* with a *Sagitta* held in its mouth, thus giving the appearance of a long conical manubrium.

Billard, 1901 (Comptes Rendus, Paris, p. 441), shows that hydroids of *Obelia* such as *O. geniculata* and *O. flabellata*, often reproduce by scissiparity. That is to say portions of the hydroid stems break off and after falling to the bottom reproduce new stocks.

Obelia gelatinosa Hincks.

Sertularia gelatinosa, Houttuyn, 1761–73, Natuurlyke historie Dieren, Planten en Mineralien, Amsterdam, vol. 17, p. 564.—Pallas, 1766, Elenchus Zoophytorum, p. 116.

Non Campanularia gelatinosa, Van Beneden, 1844, Nouv. Mém. Acad. Bruxelles, tome 17, p. 33, plates 1, 2. This is probably *Obelia longissima* (?).

Obelia dichotoma, Allman, 1864, Annals and Mag. Nat. Hist., vol. 13, p. 372.

Laomedea gigantea, Agassiz, A., 1865, North American Acal., p. 94.

Obelia gelatinosa, Hincks, 1868, British Zoophytes, p. 151, plate 26, fig. 1.—Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 356.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 430; 1905, tome 13, p. 50 (citation of literature to 1850).—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 351, figs. 39, 39a.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 48.—Rufford (edited by E. Connold), 1902, Notes on British Zoophytes, p. 57, plate 2, fig. 3.

Obelia leucostyla, Will, 1844, Horæ Tergestinæ, p. 73, taf. 2, fign. 16–19.

Obelia leucostyla+O. gelatinosa, Haeckel, 1879, Syst. der Medusen, pp. 174, 176, taf. 11, fign. 6, 7.

The hydroid forms a large compound cluster of relatively straight, tapering main stems which arise from a fibrous, spongy hydrorhiza. The main stems 100 to 250 mm. high, tree-like, dark-brown in color, and thickly branched. The branches are given off in pairs at short intervals and placed alternately on opposite aspects of stem, so as to present a subverticillate arrangement. The main stem and basal parts of the branches are composed of numerous, delicate tubes closely bound together and tapering upwards. The primary branches branch, as does main stem, into numerous, alternate ramules, annulated with 2 to 4 rings above the divisions. Hydrothecæ very small, thin-walled, smooth, and conical, and often borne upon long, tapering pedicels ringed at both ends. The margin of the hydrotheca is cut into deep denticles of a castellated form slightly hollowed at top (see Hincks). The polypites have about 24 tentacles. Gonothecæ small, ovate to club-shaped, widest near upper end, and with a flattened top and raised, crater-like aperture. They arise from the axils of the stem and are supported upon short pedicels having several rings. Each gonangium contains several medusa-buds. The main stems are horny, dark-brown and the finer and ultimate branches are pellucid white.

When set free the medusæ usually have 16 tentacles and the gonads are already beginning to migrate down the radial-canals from the sides of the manubrium.

This hydroid is exceedingly abundant upon seaweeds in shallow water along the Atlantic and Mediterranean coasts of Europe, and in America from Cape Cod to the Carolinas. Graeffe states that the hydroid is found at Trieste, Adriatic, upon mussels, and that the medusæ appear in March. It is a common hydroid on the southern coast of New England, United States, and is often found in shaded places attached to the wooden piling of docks, where its large, tree-like tufts are very conspicuous.

Obelia commissuralis McCrady.

(?) *Campanularia geniculata*, Van Beneden, 1844, Mém. Acad. Roy. de Bruxelles, tome 17, p. 34, plate 3, figs. 1–6.

Obelia commissuralis, McCrady, 1857, Gymn. Charleston Harbor, p. 95, plate 11, figs. 5–7.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 315, 351, plate 33 (*non* fig. 2), plate 34, figs. 10–21.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 91, fig. 5; 1865, North Amer. Acal., p. 91, figs. 134, 135.—Haeckel, 1879, Syst. der Medusen, p. 174.—Brooks, 1882, Studies Biol. Lab. Johns Hopkins Univ., vol. 2, p. 136.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, pp. 350, 380, figs. 36, 97.—Torrey, 1902, California University Publications, Zool., vol. 1, p. 56.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 48.

Laomedea gelatinosa, Stimpson (non Auct.), 1853, Marine Invert. Grand Manan, p. 8.

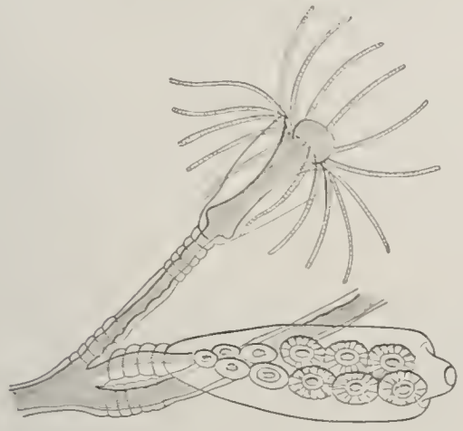
Laomedia gelatinosa, Gould, 1841, Report Invert. Animals Mass. Bay, p. 350.

Laomedea dichotoma, Leidy, 1855, Marine Invert. N. J. and R. I., p. 6, plate 9, fig. 36.

(?) *Obelia commissuralis*, Verrill, 1873, Report Commiss. Fish and Fisheries U. S., for 1871–72, p. 728, plate 37, fig. 281.

Hydroid and young medusa.—This species is found attached to stones and seaweed near low-water mark. The stems of the hydroid are tree-like and are often 125 to 150 mm. in length, although medusæ are often given off from stocks of only 25 mm. in height. The stock usually consists of a long main stem that branches but little, and the side branches spring out

nearly at right angles to main stem. These side branches give rise to numerous polypites and reproductive calycles. The longest side branches arise from about the middle regions of main stem. The branches pursue a zigzag course, each internode trending at an angle of 45° from previous one. The pedicels of the polypites arise from the internodes of the branches. They are ringed at base and at distal end, and are usually about as long as the intervals between the



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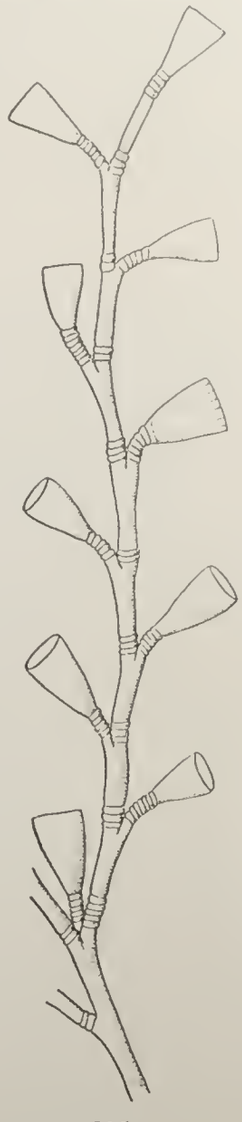

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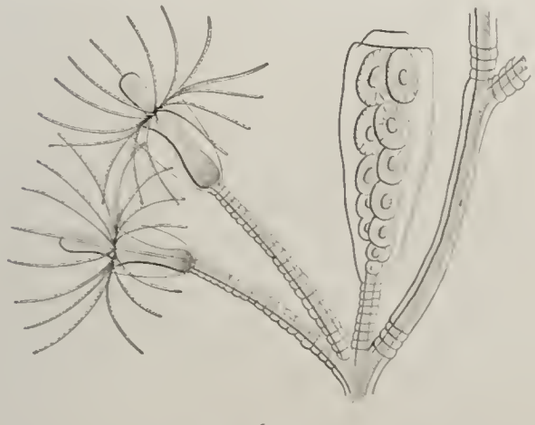

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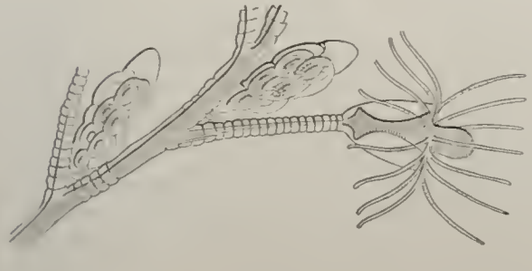

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Fig. 124.—*Obelia commissuralis*, after A. Agassiz, in North American Acalephæ.
Fig. 125.—*Obelia dichotoma*, after Hincks, in British Hydroid Zoophytes.
Fig. 126.—*Obelia "articulata"* (= *O. dichotoma*), after A. Agassiz, in North American Acalephæ.
Fig. 127.—*Obelia dichotoma*, after Hincks, in British Hydroid Zoophytes.
Fig. 128.—*Obelia pyriformis*, after A. Agassiz, in North American Acalephæ.

internodes of the branches. Each polypite has 24 to 30 long, slender tentacles. The mouth is at the extremity of a prominent proboscis. The hydrotheca is about 1.5 times as long as wide, and its upper edge is smooth and circular. The reproductive calycles are situated at the bases of the pedicels of the polypites and also at the origins of the side branches from the main stem. They are borne upon short, cylindrical stalks composed of 5 or 6 rings. The calycle is slender and conical, tapering gradually from the proximal to the distal end where it

terminates in a short neck at the upper end of which there is an opening through which the medusæ escape. From 10 to 16 medusæ are often found at one time in each calycle. When set free the young medusa usually has 16 tentacles and no trace of gonads. The tentacles are slender and about as long as the diameter of the bell.

This species extends from Charleston, South Carolina, to Eastport, Maine. It is possible that it may prove to be identical with "*Campanularia geniculata*" of Van Beneden, 1843, described from the coast of Ostende. Torrey, 1902, has discovered *O. commissuralis* in San Francisco Bay, California, between tide limits.

The distinctive characters of *O. commissuralis* are that the pedicels are distinctly annulated and. arise simply, not from distinct, swollen, shoulder-like enlargements of the stem. The hydrothecæ are goblet-shaped and deeper than those of *O. flabellata* Hincks. Their margins are simple and entire.

Obelia dichotoma Hincks.

Plate 30, figs. 1-4.

Sertularia dichotoma, Linné, 1758, Systema Naturæ, Ed. 10, reformata, p. 812; 1767, Systema Naturæ, tome 1, Pars 2, p. 1312.
Campanularia dichotoma, Meyen, 1834, Acta Acad. Caes. Leop. Carol., Nat. Cur., tome 16, Suppl. p. 317, plates 40, 41.
Laomedea dichotoma, var. α, Johnston, 1847, Hist. British Zoophytes, Ed. 2, p. 102, plate 26, figs. 1, 2.
Eucope articulata, Agassiz, A., 1865, North American Acalephæ, figs. 130, 131.
Obelia dichotoma, Hincks, 1868, British Hydroid Zoophytes, p. 156, plate 28, fig. 1.—Nutting, 1901, U. S. Fish Commission Bulletin for 1899, pp. 350, 380, fig. 37; Proc. Washington Acad. Sci., vol. 3, p. 173.—Torrey, 1902, University of California Publications, Zool., vol. 1, p. 57; 1904, University of California Publications, Zool., vol. 2, p. 15 (coast of California).—Browne, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 769 (medusa reared from hydroid to maturity).—Billard, 1905, Compt. Rend. Soc. Biol., Paris, tome 57, p. 1048 (differing rates of regeneration in still and in running water).
Obelia sphærulina, Haeckel, 1879, Syst. der Medusen, p. 173.—van Rees, 1884, Tijdschrift Nederland, Dierk., Ver. Suppl., Deel. 1, p. 587.
(?) *Obelia australis*, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, pp. 604, 920, plate 43, figs. 19-22.
(*Obelia dichotoma*=*O. australis*), Hartlaub, 1905, Zoolog Jahrbüchern, Suppl. 6, p. 580.
Obelia rhunicola, Billard, 1901, Compt. Rend. Acad. Sci., Paris, tome 133, 523.

Hydroid.—The main stems are not more than 75 to 150 mm. high and are erect, filiform, and give rise irregularly to side branches in a tree-like manner. The side branches also branch irregularly. The main stems and basal parts of the branches are of a deep horny-brown color. The pedicels of the hydrothecæ are quite long and often ringed throughout with 4 to 16 annulations. 2 pedicels often arise from the main stem at the base of a reproductive calycle. The hydrothecæ are long and nearly conical, with slightly bulging sides. The margin is very slightly sinuated, the sinuosities being so minute that they are readily overlooked excepting with high powers of the microscope. The polypites have about 24 tentacles and the mouth is at the extremity of a flaring proboscis. (See text-figures 125 to 127.)

The reproductive calycles are mounted upon long pedicels having 4 to 10 rings. They are long, cone-shaped, with a smooth outer surface, and with a tubular opening at outer end. About 15 medusa-buds in various stages of development are to be seen within each calycle.

When set free the young medusæ are about 1 mm. wide and usually have 16 (occasionally 24) tentacles. The 4 gonads are adjacent to the manubrium on the 4 radial-canals, but at the end of 3 days they are seen to have migrated outwardly to the middle of the 4 radial-canals.

The hydroid is very abundant on stones, shells, and seaweeds. It may be recognized by its small size, tree-like appearance, dark horny-brown color, and *conical* reproductive calycles.

This species is common along the Atlantic coasts of Europe, and in America from Maine to the Carolinas. It is also found on the Pacific coast at San Diego, California (Torrey).

Obelia dubia Nutting, from Alaska, is closely related to, if not identical with, *O. dichotoma*. *Obelia australis* of von Lendenfeld and Bale, from Australia and New Zealand, may be a variety of *O. dichotoma*.

Medusa.—Browne succeeded, by means of his ingenious "plunger aquarium," in rearing the medusæ of *Obelia dichotoma*, which were set free from the hydroids within the aquarium. He finds that the medusa is set free with 16 tentacles, no gonads, and 8 adradial lithocysts. The medusæ became mature at the end of 3 weeks and were then about 2.5 mm. wide, with almost flat, disk-like bell, and 60 to 84 tentacles. The cores of the tentacles project inward into the gelatinous substance as a semiglobular or oblong root, usually without a "transverse septum" (*i. e.*, usually not more than one cell in length). There are 8 adradial lithocysts on the inner sides of the tentacle-bulbs, each containing a single concretion. The stomach is short and

Plate 30.

Fig. 1. *Obelia dichotoma.* Magnified view of a part of the hydroid. Agassiz Laboratory, Newport, Rhode Island, June 28, 1895.

No. 2. *Obelia dichotoma.* Magnified view of one of the polypites of fig. 1.

No. 3. *Obelia dichotoma.* Magnified view of one of the medusæ immediately after being set free from the hydroid represented in figure 1. The gonads are now adjacent to the manubrium.

Fig. 4. *Obelia dichotoma.* The medusa 3 days after being set free from the hydroid, showing how the gonads have migrated outward down the radial-canals.

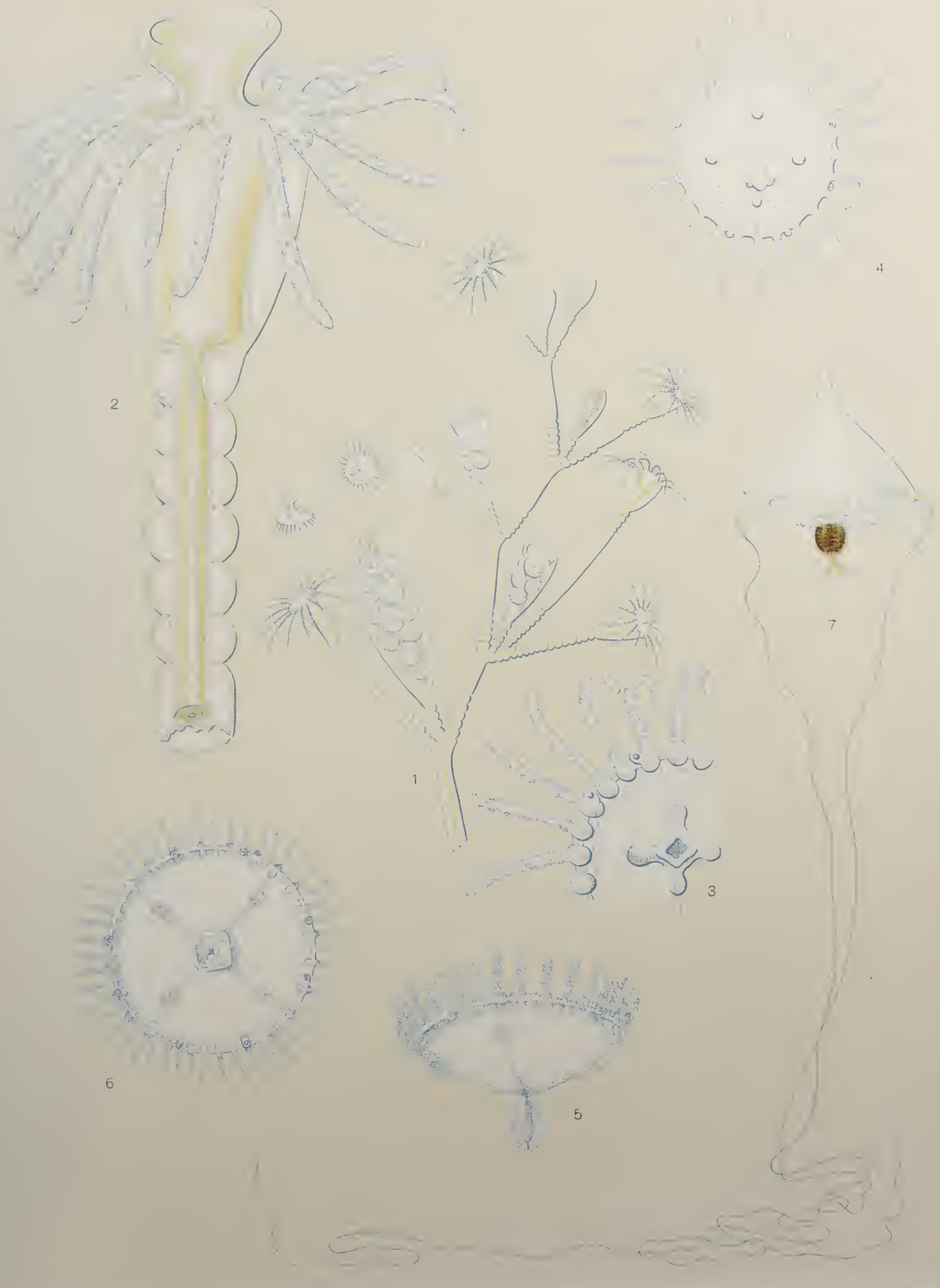
Fig. 5. Medusa of *Obelia* sp. Showing the bell inverted. This attitude is often assumed by the young medusa. Newport, Rhode Island.

Fig. 6. Medusa of *Obelia* sp. Oral view of mature medusa. Newport, Rhode Island.

Fig. 7. *Stomotoca pterophylla*, Nassau Harbor, Bahamas, April 20, 1907. Natural size. Normal aspect of the medusa. Compare with figure 3, plate 29.

See page 113; volume 1, for description of figure 7.

Drawn from life, by the author.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has 4 lips. The gonads are very small and oval and are near the middle points of the 4 radial-canals, but somewhat nearer margin than stomach. Gonads and stomach faint yellowish-brown or brown. These medusæ lived more than a month in Browne's aquaria at the Firth of Clyde, Scotland, the water in the aquarium being constantly stirred by the plunger.

Obelia australis von Lendenfeld.

Obelia australis, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, pp. 604, 920, plate 43, figs. 19–22.—Bale, 1888, Proc. Linnean Soc. New South Wales, ser. 2, vol. 3, p. 753, plate 12, figs. 1, 2. Farquhar, 1896, Trans. New Zealand Institute, Wellington, p. 460.—Hartlaub, 1901, Zoolog. Jahrbüchern, Abth. Syst., Bd. 14, p. 367; *Ibid.*, 1905, Suppl. 6, p. 580.

According to von Lendenfeld, the stems of the hydroid are creeping and adnate to foreign bodies to which the stem clings like a hydrorhiza. This creeping stem is about 12 to 16 mm. long and bears erect hydranths 3 or 4 mm. high. According to Bale, however, the hydroid is coarse, rigid, 25 to 37 mm. high, sparingly branched, with alternate hydrothecæ. These differences may be due to the influences of different environments. The hydrothecæ are mounted upon short, annulated pedicels. The reproductive calycles are elongate.

Perisarc of hydrorhiza reddish-brown, stems and branches light-orange. Entoderm of polypites brown. When set free the medusa resembles that of *O. geniculata* and has 24 tentacles. The bell of the adult medusa is flat and always reversed. Size (?) There are 30 to 40 tentacles. 8 adradial concretions upon the sides of the tentacle-bulbs. Stomach wide, urn-shaped, with 4 well-developed lips. 4 large gonads on outer parts of the 4 radial-canals. These gonads are oval to egg-shaped, and widest near their outer ends. The sperm-cells are, according to von Lendenfeld, of *entodermal* origin.

Found in Port Jackson Harbor, New South Wales, Australia, and on the east coast of New Zealand where it grows upon *Laminaria*. The medusæ are produced from May until July.

This hydroid may prove to be but a variety of *Obelia dichotoma* (see Hartlaub, 1905).

Obelia pyriformis Verrill.

Laomedia gelatinosa, Leidy, 1855, Marine Invert. N. J. and R. I., p. 6.
Eucope pyriformis, Agassiz, A., 1865, North Amer. Acal., p. 88, figs. 127–129.
Obelia pyriformis, Haeckel, 1879, Syst. der Medusen, p. 176.—Verrill, 1873, Report Commiss. Fish and Fisheries for 1871–72, pp. 390, 727.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 49.
(?) *Laomedea divaricata*, McCrady, 1857, Gymn. Charleston Harbor, p. 93.

Hydroid and young medusa.—The stems of this hydroid are usually 75 to 125 mm. in height. The tufts branch in a tree-like manner. There are no knees nor breaks in the uniformity of the stems, nor are there any swellings at the places where reproductive calycles are attached. The pedicels of the polypites are long and usually composed of 12 to 15 rings. The hydrotheca is short and flaring and with a smooth edge. The polypites have about 30 long, slender tentacles, and the mouth is situated at extremity of a prominent proboscis. The reproductive calycles vary greatly in shape. When small they are almost cylindrical with rounded corners and a slight constriction in middle; as they become larger they grow more pear-shaped; and finally they assume the shape of an elongate ellipsoid with a pointed distal end, and 3 or 4 deep constrictions upon their sides. There are from 9 to 12 medusæ developing in each calycle at once. When set free the young medusæ have 24 tentacles and 4 pear-shaped gonads which are situated very near to the manubrium.

This species is found growing upon wooden piles and upon eelgrass on the Massachusetts coast. It is remarkable for its brilliant phosphorescence. It extends southward to Charleston, South Carolina.

This hydroid is distinguished from *O. dichotoma* solely by the pyriform shape of its reproductive calycles, whereas those of *O. dichotoma* are conical.

Alexander Agassiz, 1865, p. 91, would distinguish as *O. divaricata* a hydroid similar to *O. pyriformis*, but in which the medusæ have 48 tentacles when liberated.

It seems probable that *Obelia pyriformis* and "*divaricata*" are only environmental races of *Obelia dichotoma*. (See text-figure 128.)

Obelia dubia Nutting = ? Obelia dichotoma Hincks.

Obelia dubia, Nutting, 1901, Proc. Washington Acad. Sci., vol. 3, p. 174, plate 20, fig. 1.
Obelia dubia, Nutting, from Alaska = *O. dichotoma*, Hincks, according to Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 580.

Trophosome.—Colony attaining a height of about 20 mm. Stem sparingly branched; main stem and larger branches sinuous or slightly geniculate, giving forth pedicels singly or in opposite pairs at bends. Pedicels rather long and annulated throughout; stem, also, more extensively annulated than in most species of the genus. Hydrothecæ very large, deep, tubular, with very shallow undulations around margin, from between which lines run down for a short distance on surface of hydrothecæ.

Gonosome.—Unknown.

Found at Orca, Alaska (Harriman Exped.).

This species bears some resemblance to *O. bidentata* Clark, found on the New England coast, but differs in the nature of the hydrothecal teeth, which are mere sinuosities instead of being mucronate with two denticles each, as in the latter species.

Obelia striata Clarke.

Obelia striata, Clarke, 1907, Mem. Museum Comp. Zool. at Harvard College, vol. 35, p. 9, plates 6 and 7, 13 figs.

Hydrocaulus arises from a creeping stolon. Stems simple, clustered, 8 to 10 annulations at base. Main stems rarely branched. 12 to 16 rings immediately above the origin of each pedicel, 5 to 8 at the base of each hydrotheca. Hydrothecæ pedunculate, alternately arranged, deeply campanulate, very hyaline, tapering to the base; a well-marked diaphragm and basal cavity. Margin with 14 to 16 teeth with well-developed crests projecting inward; the distal part deeply fluted, giving a series of longitudinal striations that are about one-third as long as the hydrotheca.

The gonosomes occur both on the stolon and on the stems. Sessile, nearly cylindrical, tapering to the base, strongly curved. Terminal opening in the center of a diaphragm-like membrane. Young medusa with perradial tentacles. Tropical Pacific, N. lat. 3°4′, W. long. 117° 15.8′. Attached to living shells of *Pteropods*.

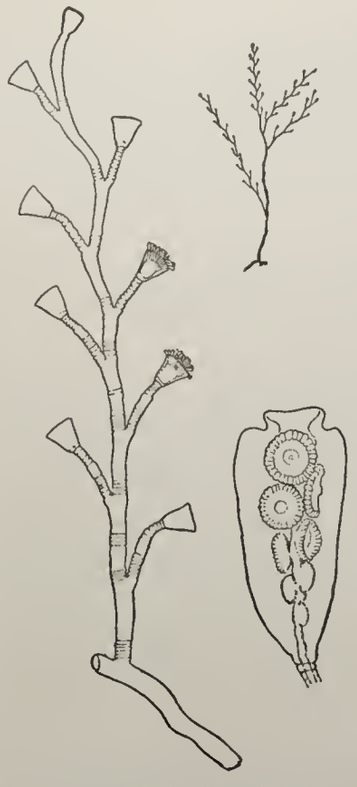


Fig. 129.—*Obelia hyalina*, after Congdon, in Proc. American Acad., vol. 42.

Obelia hyalina Clarke.

Obelia hyalina, Clarke, 1879, Bull. Comp. Zool. at Harvard College, vol. 5, No. 10, p. 241, plate 4, fig. 21.—Congdon, 1907, Proc. American Acad. Arts and Sci., vol. 42, p. 468, figs. 7–9.

Hydroid.—The stems of the hydroid arise from a creeping stolon. They attain a height of about 12 mm. and are but little branched. They are annulated at base and divided into internodes of equal lengths, each one of which is annulated at its proximal end and bears at its distal end a pedunculated hydrotheca. The pedicels of the hydrothecæ are annulated at both distal and proximal ends, and occasionally annulated throughout. Hydrothecæ short, tapering toward base. Rim entire. There is an intrathecal partition near base of polypite. Branches often arise in the axils of the pedicels. These are annulate at base and give rise to hydrothecæ like those of main stem. Reproductive calycles small, being about twice as long as hydrothecæ. They are borne on short stalks that are annulated throughout and arise from the axils of the pedicels of the hydrothecæ. The calycle tapers toward base and is rounded off at distal end, where there is a flaring terminal opening. Medusæ are developed in the calycles. The hydroid is very hyaline.

This species was found 10 miles north of Zoblos Island by Clarke.

The best figures of this form are those of Congdon, who obtained specimens in Bermuda, where it grows upon sponges, algæ, and large hydroids of the shallow waters.

Obelia plana Haeckel.

Thaumantias plana, Sars, 1835, Beskriv og Jagttagelser, Bergen, p. 28, plate 5, figs. 13 *a–g*.
Campanularia flabellata, Hincks, 1866, Annals and Mag. Nat. Hist., vol. 18, p. 297.
Obelia flabellata, Hincks, 1868, Hist. British Hydroid Zooph., p. 357, plate 29, 3 figs.—Nutting, 1901, Bulletin U. S. Fish Commission for 1899, pp. 358, 380, fig. 35.—Melley, Hincks and Herdmann, 1886, Hydroids L. M. B. District, p. 102.—Hargitt, 1908, Biol. Bulletin, vol. 14, p. 109, fig. 12 (medusa).—Billard, 1901, Compt. Rend. Paris, tome 133, p. 441.
Obelia plana, Haeckel, 1879, Syst. der Medusen, p. 177.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 140; *Ibid.*, tome 13, p. 95 (literature 1835–1850).

The main stems are about 200 mm. high, filiform, somewhat zigzag, and strongly annulated with about 2 to 5 rings above the points of origin of the branches. Main stem dark horny-brown color. Branches alternate, fairly short and fan-shaped, more or less dichotomous in their manner of ultimate branching, and ringed above each division. They generally fork immediately beyond point of origin, and arms of fork trend in opposite directions, thus giving a subverticulate appearance to the ramification.

The hydrothecæ are alternate, short, widely flaring, and conical, with simple, entire margins. They are borne on completely ringed and tapering pedicels of variable length, some being short, others long, and having a range of about 3 to 10 rings.

The reproductive calycles arise from the axils of the stems and are ovate to club-shaped, somewhat flattened at outer end, and with a short tubular orifice. They are attached by short ringed stalks. (See text-figure 130.)

Found in rocky tide-pools on the British and Norwegian coasts, and identified by Nutting from depths of 4 to 5 fathoms near Woods Hole, Massachusetts, and in Long Island Sound.

According to Hargitt the medusa which is liberated by *O. flabellata* Hincks is at liberation 0.4 to 0.5 mm. in diameter, and has 24 tentacles, 8 adradial concretions, and 4 well-developed oval gonads near the middle of its radial-canals. Billard found that the hydroid often breaks into pieces and these upon anchoring themselves develop into new stocks.

Obelia borealis Nutting.

Obelia borealis, Nutting, 1901, Proc. Washington Acad. Sci., vol. 3, p. 174, plate 19, figs. 4, 6.

Trophosome.—Colony sometimes attaining a height of 440 mm., usually much shorter; stem not truly fascicled, although several stems may be interwoven, exceedingly long and slender, sinuous, giving off lateral branches in pairs on proximal part and more often singly on distal part; branches with a strong tendency to verticillate arrangement, forming oblique angles with the stem and divided into numerous branchlets in a flabellate manner. Pedicels short and completely annulated, or long and annulated only at ends, set on broad shoulders of the stem. Hydrothecæ funnel-shaped, sides usually straight, aperture with an even rim. Hydranths not well preserved in specimens examined.

Gonosome.—Gonangia borne in axils of branches and branchlets, oblong-ovate, truncated above, having a collar in mature specimens; aperture apparently very large, pedicels strongly annulated. The gonangia of the specimens examined were filled with developing medusæ of the regular *Obelia* type.

Found at Yakutat, Alaska (Harriman Expedition).

This species is related to *O. flabellata*, but the hydrothecæ are much deeper than in *O. flabellata*, in which they are subtriangular in outline. It also bears some resemblance to *O. commissuralis*, which, however, is a much more delicate species, with smaller and more campanulate hydrothecæ.

Obelia geniculata Allman.

Sertularia geniculata, Linné, 1758, Systema Naturæ, ed. 10, p. 812; 1761, Fauna Suecica, p. 541; 1767, Syst. Naturæ, tome 1, Pars 2, p. 1312.
Campanularia geniculata, Meyen, 1834, Acta Acad. Caes. Leop. Carol., Nat. Cur., tome 16, Suppl., p. 319, tab. 41, figs. 3–5.
Laomedia geniculata, Johnston, 1838, History of British Zoophytes, p. 151, plate 21, figs. 1, 2.
Eucope diaphana, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 322, 352, plate 34, figs. 1–9*a*.
Eucope alternata, Agassiz, A., 1865, North Amer. Acal., p. 86.
Obelia geniculata, Allman, 1864, Annal. and Mag. Nat. Hist., ser. 3, vol. 13, p. 372; 1871, Monog. Tubularian Hydroids, p. 141, fig. 59.—Hincks, 1868, History of British Zoophytes, p. 149, plate 25, figs. 1, 1*a*.—Verrill, 1873, Report of Commiss. Fish and Fisheries, U. S. A., for 1871–72, p. 727.
Obelia diaphana + *O. lucifera* (?), Haeckel, 1879, Syst. der Medusen, p. 175.

Obelia geniculata, DE VARENNE, 1882, Archiv. Zool. Expér. et Générale, tome 10, p. 659, planche 35.—BOURNE, 1883, Quart. Journ. Microscop. Sci., vol. 23, p. 621 (origin of sex cells).—WEISMANN, 1883, Entstehung Sexualzellen bei Hydromedusen, Jena.—BALE, 1884, Catalogue Austral. Mus., Sydney, Zooph., p. 59, plate 2, fig. 2.—MARKTANNER-TURNERETSCHER, 1890, Ann. naturb. Hofmus. Wien, Bd. 5.—BALE, 1893, Proc. Royal Soc. Victoria, p. 99 (from Victoria, Australia).—PICTET, 1893, Revue Suisse de Zool., tome 1, p. 24 (from Amboina, Malay Archipelago).—HARTLAUB, 1894, Wissen. Meeresuntersuch. Kommis. Meere Kiel, Biol. Anst. Helgoland, ser. 2, Bd. 1, p. 171.—FARQUHAR, 1896, Trans. New Zealand Institute, Wellington, vol. 28, p. 460 (found on coast of New Zealand).—NUTTING, 1896, Journal Marine Biol. Assoc. Plymouth, ser. 2, vol. 4, p. 147; Bulletin U. S. Fish Commission, vol. 19, pp. 351, 380, figs. 38, 98.—BROWNE, 1897, Irish Naturalist, p. 245.—HILGENDORF, 1898, Trans. New Zealand Institute, Wellington, vol. 30, p. 204, plate 17, figs. 2, 2*a*.—HARTLAUB, 1901, Zool. Jahrbüchern, Abth. Syst., Bd. 14, p. 362 (from New Zealand).—BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 430; *Ibid.*, tome 13, p. 51 (literature cited to 1850).—HARGITT, 1902, American Naturalist, vol. 35, p. 382, fig. 18; p. 589, fig. 55.—TORREY, 1902, University of California Publications, Zool., vol. 1, p. 58 (from the coast of California); 1904, *ibid.*, vol. 2, p. 15.—HARTLAUB, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 581, fig. D2 (coast of Chile, Straits of Magellan, Falkland, Terra del Fuego, Kerguelen Islands).—Billard, 1901, Compt. Rend., Paris, tome 133, p. 441.

(?) *Eucope obliqua*, BROOKS, 1881, Studies Marine Lab. Johns Hopkins Univ., vol. 2, p. 140; 1890, Handbook of Invertebrate Zoology, p. 30, fig. 15.

Obelia diaphana, BROWNE, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 281.—HARGITT, 1904, Bull. Bureau of Fisheries, U. S., vol. 24, p. 48, 1 fig.

(?) *Thaumantias lucifera* (*lucida*), FORBES, 1848, British Naked-eyed Medusæ, p. 52, plate 10, figs. 2*a*–*g*.

Obelia lucifera, BROWNE, 1896, Proc. Zool. Soc. London, p. 481; 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 170.—BEDOT, 1905, Revue Suisse de Zool., tome 13, p. 140 (literature to 1850).

(?) *Eucope polygena*, AGASSIZ, A., 1865, North Amer. Acalephæ, p. 86, fig. 126.

Var. *Eucope fusiformis*, AGASSIZ, A., 1865, *Ibid.*, p. 90, figs. 132, 133.

Adult medusa.—Bell flat and disk-shaped, about 6 mm. in diameter. There are about 100 stiff, slender tentacles, each about one-quarter as long as diameter of bell. Tentacles quite straight, projecting radially outward from edge of disk, their outer surfaces covered with a large number of spindle-shaped nematocyst-capsules; their cores are composed of a single row of disk-shaped, highly vacuolated, entodermal cells, which project beyond the bases of the tentacles centripetally inward into the gelatinous substance of the bell; each tentacle is thus provided with a bulb-shaped "root" or insertion.

The velum is extremely small and consists of a barely perceptible web stretching between the bases of the tentacles. There are 8 adradial lithocysts, 2 in each quadrant. Each lithocyst is a closed vesicle and contains a single, spherical concretion. The lithocysts arise from the ventral side of the bulbs of 8 of the tentacles. There are 4 straight, narrow radial-canals and a slender circular canal. The stomach is very short and provided with 4 prominent lips. There is no peduncle. The 4 gonads are developed upon the 4 radial-canals. They are spherical and usually found nearer the circular canal than stomach. In the female each gonad contains 4 or 5 large ova. Stomach, gonads, and tentacle bases have a slightly milky or yellowish color, all other parts of the medusa being transparent.

Hydroid and young medusa.—The stems of the hydroid arise from a creeping stolon usually found growing upon seaweed near low-water mark. They are rarely over 25 mm. high, are zigzag, and rarely branch. Stem is jointed at each of the flexures and thickened immediately below them, so as to form a series of projecting knees or rests from which the pedicels arise. The pedicels are short and usually consist of about 4 to 6 rings. They are inclined at an angle of about 30° with main stem and taper slightly outwardly. The hydrothecæ are short, being nearly as wide at the aperture as they are long. They are nearly conical, with slightly bulging sides and a smooth upper edge. The reproductive calycles are borne upon a short stalk consisting of 3 to 4 rings. They are club-shaped and taper gradually from base to outer end, where they are widest. A short, tubular orifice arises from the distal summit of the calycle. Each gonangium bears numerous medusa-buds.

The medusa, at the time of liberation, usually possesses 24 tentacles (occasionally 16) and 4 gonads close to the sides of the manubrium. The young medusa is transparent and frequently swims with the bell rim everted. As development proceeds, the tentacles increase in number, becoming nearly 100, and the gonads migrate outwardly along the 4 radial-tubes, so that in the mature medusa they often lie nearer to the periphery of the bell than to the manubrium.

Very common all along the northern coasts of Europe and the Atlantic coast of America, north of the Carolinas. It is of world-wide distribution, having been found at Arru Islands, Amboina, Malay Archipelago; Australia, New Zealand, coast of Chile, Terra del Fuego, Straits of Magellan, Kerguelen, Falkland Islands, and the coast of California.

Weismann and de Varenne find that the germ-cells in *Obelia geniculata* originate in the entoderm of the stem of the hydroid, and then migrate into the medusa-bud, finally pushing through the entoderm into the ectoderm, which thus incases them in the free medusa. Billard, 1901, finds that this hydroid often reproduces itself through scissiparity.

"*Eucope*" *polygena* A. Agassiz, 1865, appears to be only a variety or environmental race of *Obelia geniculata*.

130.

131.

132.

Fig. 130.—*Obelia "flabellata"* = *O. plana*, after Hincks, in British Hydroid Zoophytes.
Fig. 131.—*Obelia "flabellata,"* after Hincks, in British Hydroid Zoophytes.
Fig. 132.—*Obelia geniculata* var. *polygena*, after A. Agassiz, in North American Acalephæ.

This variety is closely related to *Obelia geniculata*, but is said to be distinguished by the stoutness of the main stem, the great number of medusæ developed in a single calycle, and the wavy outlines of the somewhat bottle-shaped reproductive calycles. The young medusa has 24 tentacles and 4 gonads close to the manubrium. The tentacles are somewhat larger than in the young medusa of *O. geniculata*. It is found growing on stems of *Laminaria* in small branching tufts from 25 to 50 mm. in height, at Nahant, Massachusetts.

FIG. 133.—*Obelia "diaphana"* = *O. geniculata*, after A. Agassiz, in North American Acalephæ.

Obelia geniculata may be at once recognized as the creeping hydroid with short, unbranched, erect, zigzag stems, growing in great quantities over the fronds of *Laminaria*. Hardly a piece of kelp upon our coast is free from this hydroid. It is a conspicuous object on account of its light coloration standing out in contrast with the dark-brown of the kelp.

The hydroid called *Eucope fusiformis* by A. Agassiz appears to be identical with *O. geniculata*, but it gives rise to medusæ which, when liberated, have 48 long, slender tentacles and 4 linear gonads near middle of the 4 radial-canals. It appears thus to be a variety of *O. geniculata*, which gives rise to medusæ in a more advanced condition of growth than is usual in the typical hydroid. It occurs on the coast of Massachusetts.

Obelia griffini Calkins.

Obelia griffini, CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 357, plate 4, figs. 18–18c, plate 6, fig. 18D.

The hydroid forms a colony about 25 to 50 mm. high. Stems profusely branched, growing on creeping stolons. Branches regularly alternate, about 0.5 mm. apart. The main stems have 6 rings at the base and above the joints up to the middle of the internodes. Hydrothecæ 0.25 to 0.35 mm. long and borne on stems 0.1 mm. long, ringed throughout (about 9 rings). Rim plain. Deep and gracefully curved hydrothecæ. The diaphragm is a simple partition. The gonothecæ are 0.8 to 1 mm. long and 0.25 to 0.3 mm. wide, and nearly uniform in diameter. 6 to 8 medusæ develop at the same time. The oldest medusa-buds have about 24 tentacles. Puget Sound. Pacific coast of the United States.

Obelia fragilis Calkins.

Obelia fragilis, CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 355, plate 3, figs. 15–15B, plate 6, fig. 15C.

Hydrocaulus clinging, never erect. Hydrothecæ bell-shaped, alternate. Margins sinuous. Branches annulated throughout. Gonophores unknown. Port Townsend, Puget Sound, Pacific coast of United States, on *Aglaophenia*. In other respects similar to *O. griffini*.

Obelia surcularis Calkins.

Obelia surcularis, CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 355, plate 3, figs. 14–14B, plate 6, fig. 14C.

Hydrorhiza branched and creeping; never more than one branching stem. Stems erect and not over 26 mm. long. Branches regularly alternate, turned upward, generally ending in long filiform tendrils, slightly expanded at the end, and in some cases bearing 1 or 2 hydrothecæ. 6 to 8 annulations at base of main stem and 3 to 4 above each branch. The stems of the hydrothecæ are often ringed throughout and taper from point of origin to calycle.

The hydrotheca is slightly swollen at the center and has a slightly everted and smooth margin. The diaphragm is a simple shelf projecting inwards from the cup, and the basal chamber is not separated from cavity of stalk.

The gonothecæ are borne in axils and also on the branches on short ringed stalks. They expand rapidly from base to end, and the extremity is flat with a very shallow, flat projection containing the aperture. Medusæ develop on all sides of the blastostyle, as many as 28 developing at once. The older medusa-buds have about 24 tentacles. The hydrothecæ are 0.3 mm. long, 0.25 mm. wide at margin. Peduncles are 1.2 to 5 mm. long. Gonotheca 0.75 to 0.9 mm. long and 0.15 mm. wide at the widest point. The hydranths have about 24 tentacles.

Found on grasses at Port Townsend, Puget Sound, Pacific coast of the United States. Distinguished by its numerous long tendrils or stolon-like branches.

Obelia gracilis Calkins.

Obelia gracilis, Calkins, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 353, plate 3, figs. 13–13c, plate 6, fig. 13d.

The hydrorhiza is creeping and slightly branched. Stems of hydroid erect, simple or slightly branched, 6 to 20 mm. high. The main stem has 4 to 6 rings at base and 2 or 3 above each branch. The side branches have 4 or more annulations at base and are occasionally provided with tendril-like processes. The hydrothecæ alternate at angles formed by the very slight zigzag of the main stem; usually there are 2 hydrothecæ at each angle, but in the older angles, near the base of the main stem, one hydrotheca is at the end of a long stalk having 3 to 4 annulations at base and 3 below the hydrotheca; the other hydrotheca is on a short stalk borne in the axil of the former. The cup of the short-stalked hydrotheca is about 0.36 mm. long and 0.32 mm. wide, while that on the long stalk is smaller and only about 0.32 mm. long and 0.19 mm. wide. The margins are plain and the diaphragms double. The hydranths have about 28 tentacles. The gonothecæ are club-shaped, widest at outer end, 0.75 mm. long, and 0.26 mm. wide at end. The large medusa-buds have about 28 tentacles. Medusæ develop from all sides of the blastostyle.

Found on grasses at Port Townsend, Puget Sound, Pacific coast of North America.

The stems of this hydroid resemble "*Eucope*" *diaphana* A. Agassiz, but the stalks of the hydrothecæ are only partially ringed instead of being ringed throughout, as in Agassiz's form. The gonothecæ are, however, quite different from those of *Obelia diaphana*.

Obelia corona Torrey.

Obelia corona, Torrey, 1904, Univ. California Publications, Zool., vol. 2, p. 14, figs. 5, 6.

Colonies very low; stems simple, short, slightly flexuous, arising from a creeping stolon, with 3 to 6 annulæ distal to each pedicel. Hydrothecæ long, narrow, tapering. Margin with 8 to 10 teeth, each with 2 sharp cusps, pedicel short, completely annulated with 2 to 4 annulæ. Hydranth with about 24 tentacles. Gonangia club-shaped with wide aperture, 3 times as long as broad. Pedicel short, completely annulated with 2 to 4 rings. Numerous medusæ, largest with 24 tentacles. The hydrotheca ranges from 0.43 to 0.44 mm. long and 0.18 to 0.20 mm. wide. Gonangia, including pedicel, 0.76 mm. long and 0.2 mm. wide. San Diego Bay, California, under wharves and creeping over sponges.

Obelia helgolandica Hartlaub.

Obelia helgolandica, Hartlaub, 1884, Zeit. für wissen. Zool., Bd. 41, p. 165, text-fig. 11, taf. 11, fign. 3, 4, etc.—1894, Wissen. Meeresuntersuch. Kom. Kiel, Helgoland, ser. 2, Bd. 1, p. 173.

Medusa flat, shield-shaped, 0.3 mm. wide. When mature there are about 80 tentacles, but when set free from hydroid there are but 24. Tentacles not half as long as bell-radius. Manubrium short and thick, with 4 wide lips with their radial corners turned upward. The 4 gonads lie upon the outer thirds of the 4 radial-canals, not touching ring-canal. Hartlaub shows that in this medusa, as in *Obelia adelungi*, the germ-cells originate upon the upper, interradial, ectodermal walls of the manubrium. They begin to appear upon the second day after the medusa is set free from the hydroid, and only later do they migrate outward to their position in the gonads on the radial-canals. The young eggs all originate in the ectoderm of the manubrium, but later some of them migrate into the entoderm of the manubrium. The young eggs of the ovaries on the radial-canals are commonly found in the entoderm, but a number of these migrate into the ectoderm to ripen. The sperm-cells originate in the ectodermal, interradial walls of the manubrium and later migrate into the ectoderm of the gonads on the radial-canals. As Hartlaub says, this process would indicate that primitively the gonads were upon the manubrium as in the Anthomedusæ and that their position upon the radial-canals is secondarily acquired.

Hydroid.—The hydroid of *Obelia helgolandica* forms thin zigzag stems about 100 to 110 mm. high. These stems are brown; the side branches are short and arise alternately from the sides of the main stem. These side branches also give rise to several alternate ramuli. The hydrothecæ are large, about 0.5 mm. long, smooth-lipped, and mounted on pedicels which are about 8 mm. long and ringed throughout. Gonangia about 1 mm. long, often curved, mounted upon short-ringed pedicels, which usually arise from lower parts of the hydrocauli.

Found by Hartlaub at great depths off Helgoland, German Ocean. Medusæ are found late in September.

Obelia adelungi Hartlaub.

Obelia adelungi, Hartlaub, 1884, Zeit. für wissen. Zool., Bd. 41, p. 164, text-fig. 1, taf. 11, fign. 1, 2, 5, etc.; taf. 12, fig. 31; 1894, Wissen. Meeresuntersuch. Kommis., Meere Kiel, Helgoland, ser. 2, Bd. 1, p. 173.

Medusa flat, shield-shaped, about 2.5 mm. wide. 24 tentacles, which are not quite half as long as bell-radius. Manubrium less than one-third as long as bell-radius; cylindrical, with 4 lips. 4 gonads on outer thirds of the 4 radial-canals, but not extending to ring-canal. When set free there are no gonads upon the radial-canals. Colorless.

The hydroid is dense, tree-like, and thick-stemmed; brown in color and about 80 to 100 mm. high. The branches arise on alternate sides of the main stem from the ground upward. The branching of the side branches is, however, quite irregular, but profuse. Hydrothecæ about 0.5 mm. long, with simple entire edges, without notches on margin. The pedicels of the hydrothecæ are about 0.8 mm. long and usually ringed throughout. Gonangia elongate, conical, and mounted upon very short pedicels. They are developed at the axils between branches, and most of them are near the base of the stock.

Found late in September at Helgoland, German Ocean, at great depths.

Hartlaub showed that in this medusa and in *Obelia helgolandica* the germ-cells begin to develop upon the second day after the medusa has been liberated from the hydroid. The germ-cells originate in the ectoderm upon the 4 upper, interradial sides of the manubrium, and only later do they migrate into their final position over the radial-canals. After the eggs have begun to differentiate in the ectoderm of the manubrium, some of them migrate through the basement membrane and enter the entoderm. When the medusa is mature, the greater number of the young eggs in the gonad are found in the entoderm, but later a number of them migrate into the ectoderm, where they mature. The sperm-cells originate in the ectoderm and migrate into the spermaries, where they remain in the ectoderm.

Hartlaub states that this medusa is quite different from *O. gelatinosa*.

Obelia bidentata Clarke.

Obelia bicuspidata+O. bidentata, Clarke, 1875, Transactions Connecticut Acad. Sci., vol. 3, p. 58, plate 9, fig. 2.
Obelia bidentata, var., Pictet, 1893, Revue Suisse de Zoologie, tome 1, p. 25, plate 1, figs. 20, 21 (from Amboina).
Obelia bidentata, Marktanner-Turneretscher, 1890, Ann. naturh., Hofmus. Wien, Bd. 5 (from the Arru Islands).
(*Obelia bicuspidata=Obelia bidentata*) ?, Nutting, 1901, Bull. U. S. Fish Commission for 1899, p. 351.
(?) *Obelia austro-georgiæ*, Jäderholm, 1904, Archiv. Zool. Expér., sér 4, tome 3, p. vii.

O. bidentata and *O. bicuspidata* of Clarke are probably one and the same species, for Nutting found an intergrading form between the two. In *O. bicuspidata* the colony is about 80 mm. high, with straight, irregularly branched main stems. Pedicels of the hydrothecæ have 10 to 15 annulations. The hydrothecæ are very deep and tubular, with margins armed with bimucronate teeth, between which lines originate which pass longitudinally down the surface of the hydrotheca.

O. bidentata resembles *O. bicuspidata*, but attains a larger size, has shorter pedicels with only 4 to 6 annulations, and proportionately wider hydrothecæ. Nutting suspects that the two "species" are but extreme forms of an intergrading series.

No gonosome known. Medusa unknown. Found by Clarke and Nutting in or near Long Island Sound, Atlantic coast of southern New England; and by Pictet and Marktanner-Turneretscher in the Malay Archipelago, at Amboina, and the Arru Islands.

This species is distinguished by its long subcylindrical hydrothecæ with their longitudinal ridges and strongly dentate margin.

Obelia? bifurca Hincks, 1887, Journ. Linnean Soc. London, vol. 21, p. 133, plate 12, fig. 1, resembles *O. bicuspidata* Clarke, but is stouter and longer. The calycles are very slender and lineated longitudinally with 8 to 10 lines, extending from the rim nearly to base. Pedicels are long and taper upwardly, and the stem is compound. The rim is cut into about 12 broad bicuspid denticles. Found on *Nellia oculata* at the Mergui Archipelago off the coast of Tenasserim.

Obelia austro-georgiæ, Jäderholm, 1904, from Cumberland Bay, South Georgia, Antarctic, resembles *O. bifurca* Hincks, but has only 12 wide shallow teeth and its hydrothecæ are smaller and are fluted. The stems become 15 mm. high. This form may not be *Obelia*, however, but *Campanularia* for the gonosome is not known.

Obelia longissima Hincks.

Sertularia longissima, Pallas, 1766, Elenchus Zoophytorum, p. 119.
Laomedea dichotoma, var. β, Johnston, 1847, History British Zoophytes, Edit. 2, p. 102.
(?) *Campanularia gelatinosa*, Van Beneden, 1844, Acad. Roy. Bruxelles Mém., tome 17, p. 33, plates 1, 2.
Laomedea longissima, Alder, 1857, Trans. Tynes. Nat. Field Club, vol. 3, p. 121.
Obelia longissima, Hincks, 1868, Hist. British Hydroid Zooph., p. 154, plate 27, 3 figs.—Clarke, 1876, Scientific Results Exploration of Alaska, vol. 1, p. 212 (from Unalaska, Alaska).—Nutting, 1901, Bull. U. S. Fish Commission for 1899, pp. 351, 379, fig. 41.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 457; *Ibid.*, 1905, tome 13, p. 95 (citation of literature to 1850).—Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 582, fig. e2.
(?) *Eucope polystyla*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 242, taf. 8, fig. 18.
Obelia polystyla, Haeckel, 1879, Syst. der Medusen, p. 117.

Main stems usually black or horny-brown, and about 300 mm. long, very flexible, and tapering gradually from base to tip. Main stem nearly straight, but slightly zigzag, the angle being at points of origin of the branches. The branches are light-colored and arise at short intervals from the main stem, standing out nearly at right angles to the stem itself. These branches are longest near the base, but shorter higher up, and arise from the stem alternately, on opposite sides, in a palmate manner. The branches themselves branch in a manner similar to that of the main stem. The main stem and each branch are annulated with 3 to 6 rings above the point of origin of each branch or ramulation.

Fig. 134.—*Obelia longissima*, after Hincks, in British Hydroid Zoophytes.

The hydrothecæ are campanulate, quite large, delicate, and elongate. They are nearly conical, with slightly bulging sides. The rims are delicately notched with very small, blunt, shallow teeth. These hydrothecæ are borne upon quite long pedicels, usually ringed throughout with about 8 to 15 rings, and tapering from their point of origin to base of hydrotheca.

The reproductive calycles arise from relatively short pedicels in the axils of the stems. They are ovate to conical, with smooth outer surface and with the terminal aperture at the extremity of a crater-like projection. About 10 to 15 medusa-buds are seen developing at one and the same time in each calycle. The calycles break off very readily, and on this account are rarely seen in preserved or roughly handled specimens. When set free, the medusa has 20 to 24 tentacles.

This hydroid is abundant on the Atlantic coasts of Europe and in America north of the Carolinas. It has been found by Saemundsson at Iceland, and by Hartlaub off the Pacific coast of Chile and in the Straits of Magellan. Clarke records it from Alaska.

Billard, 1904 (Annal. Sci. Nat., Sér. 8, Zool., tome 20), finds that at St. Vaast, on the northwest coast of France, there are two varieties of *O. longissima*; a large form in deep water, and a smaller variety along the shore; in which latter the indentations of the margin are greatly reduced so as to be all but indistinguishable.

This common *Obelia* may be at once recognized by its long, flexible, black, thread-like, main stems, and its delicate alternate branches, all tapering from base to summit. The mature medusa can not be distinguished from that of other species of *Obelia*.

Obelia chinensis Marktanner-Turneretscher.

Obelia chinensis, Marktanner-Turneretscher, 1890, Ann. Hofmuseum Wien, Bd. 5, p. 210, taf. 3, fign. 6, 7.

Stems 100 mm. long, zigzag, sparingly branched, with 3 to 5 rings on each internode of the main stem and at base of each branch. The pedicels of the hydrothecæ are ringed at both ends, but free of rings in the middle. Pedicels 0.5 to 0.9 mm. long. Hydrothecæ bell-shaped, with plain margin, 0.5 mm. long, and 0.3 to 0.4 mm. wide at the orifice. This form is closely related to, if not identical with, *O. plana*, but pedicels of hydrothecæ are said to be longer.

Yellow Sea, coast of China.

Obelia nigra Browne.

Obelia nigra, Browne, 1900, Proc. Royal Irish Acad., ser. 3, vol. 5, p. 721; 1903, Bergens Museums Aarbog, No. 4, p. 16; 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 770.

Mature medusa.—Bell slightly cone-shaped, 5.5 mm. wide, 150 to 200 tentacles. About 6 large black or brown basal bulbs in each quadrant; these are twice as large as the colorless bulbs of the remaining tentacles. 8 lithocysts, each with one concretion. 4 radial-canals, 4 lips, 4 small globular gonads on outer halves of radial-canals two-thirds the distance from stomach to margin of bell. English, Scottish, and Irish coasts; Bergen, Norway; Halifax Harbor, Nova Scotia. Hydroid unknown.

This *Obelia* medusa is readily distinguished by the dark-brown, almost black pigment at the bases of some of the tentacles. I have taken it in considerable numbers in Halifax Harbor, Nova Scotia, in September. Torrey, 1909 finds a medusa with purple tentacle-bulbs, on the coast of California and has named it *O. purpurea*. (See appendix.)

Obelia (?) plicata Hincks.

Obelia (?) *plicata*, Hincks, 1868, Hist. British Hydroid Zooph., p. 159, plate 30, fig. 1.
Obelia plicata, Nutting, 1901, Proc. Washington Acad. Sci., vol. 3, p. 173.

This is a coarse, tree-like hydroid about 15 to 20 mm. high. Main stem very thick at base, but tapers upward to a thread-like end. It is composed of a bundle of delicate tubes closely adherent one to the other. The branches are profuse and given off somewhat irregularly, although more or less alternately. They are very long and taper as does the main stem. The hydrothecæ are conical, quite wide, and with even rims without notches or teeth. They are mounted upon pedicels having about 4 to 12 rings. Reproductive calycles unknown. This hydroid may not produce free medusæ and may possibly belong to the genus *Campanularia*. Hincks describes it from the Shetland Islands, and Nutting records it from Puget Sound and Alaska. Medusa unknown.

Obelia arruensis Marktanner-Turneretscher.

Obelia arruensis, Marktanner-Turneretscher, 1890, Annalen Hofmuseum Wien, p. 210, taf. 3, fig. 8.

Stems about 50 mm. high. Branching similar to that of *O. plicata* Hincks, but with somewhat longer pedicels of the hydrothecæ. Hydrothecæ bell-shaped, 0.6 mm. long, 0.36 mm. wide at the orifice, and with 14 to 18 teeth. Gonothecæ arise in clusters from stem and are about 0.7 mm. long, goblet-shaped, widest above. They resemble those of *Campanulina turrita* Hincks. Found at the Arru Islands, tropical Pacific.

PLATE 31.

Fig. 1. *Tiaropsis rosea*, young immature medusa. Tortugas, Florida, June, 1898.

Fig. 2. *Tiaropsis rosea*. One of the marginal sense-organs of the medusa represented in figure 1.

Figs. 3 and 4. *Tiaropsis rosea*, young medusa with gonads beginning to develop. Figure 4, marginal sense-organ of the medusa shown in figure 3. Tortugas, Florida, July, 1898.

Fig. 5. *Eucope parvigastra*, mature medusa. Tortugas, Florida, July, 1898.

Fig. 6. *Obelia* sp. A sector of the bell-margin showing a radial-canal and a lithocyst. Agassiz Laboratory, Newport, Rhode Island, September 18, 1892.

Figs. 7 and 8. *Obelia* sp. Nassau Harbor, Bahamas, July, 1903.

Figs. 9 and 10. *Clytia folleata*, mature medusa. Nassau Harbor, Bahamas, June, 1903. See page 264.

Fig. 11. *Tiaropsis diademata*, mature male. Newport, Rhode Island, April 24, 1897.

See page 238 for description of figures.

Drawn from life, by the author.

A.Hoen & Co

Obelia serratula Bale.

Obelia serratula, Bale, 1888, Proc. Linnean Soc. New South Wales, vol. 3, p. 757.—Thornely, 1900, Zoological Results, A. Willey, part 4, p. 453, plate 44, fig. 5, Cambridge, England.

Stems branched and with stolons growing downward from peduncles of hydrothecæ. Stems over 10 mm. high. Hydrothecæ short, broad, flaring, with about 10 to 12 large triangular teeth. Floor of hydrotheca raised above base, leaving a large cavity beneath it. The gonotheca is borne upon a short ringed stem, is oval, truncated above, and with smooth outer surface. The gonothecæ arise from the sides of the stems and each bears several medusæ. East coast of Australia, New Britain, South Pacific. Found in shallow water—40 fathoms—on ropes, etc.

Obelia linearis Thornely.

Obelia linearis, Thornely, 1900, Zoological Results, A. Willey, part 4, p. 453, plate 44, fig. 6, Cambridge, England.

Stems branched, 7 mm. high. Hydrothecæ deep, with about 12 blunted teeth on margin, pedicels tapering, ringed throughout with 12 to 16 rings. Gonothecæ borne in axils of peduncles. They are elongate, oval, smooth, and with orifice prominent, recurved, and gaping. There are a number of medusa-buds within the gonotheca. Stems horn-colored below, transparent above. Tropical Pacific. (New Britain?)

Obelia delicatula Thornely.

Obelia delicatula, Thornely, 1900, Zoological Results, A. Willey, part 4, p. 453, plate 44, fig. 7, Cambridge, England.

Stems 4 mm. high, simple and unbranched, borne on a creeping stolon, which also bears gonothecæ; ringed at their bases, and here and there above, and bear 3 or more rings under the hydrothecæ. Hydrothecæ elongate, goblet-shaped, with about 12 blunt teeth at rim. Gonothecæ blunt, short, with flaring margins, and with several medusa-buds arising singly from basal stolon of hydrothecæ. Blanche Bay, New Britain, South Pacific.

Obelia angulosa Bale.

Obelia angulosa, Bale, 1888, Proc. Linnean Soc. New South Wales, ser. 2, vol. 3, p. 752, plate 12, fig. 3.

Stems monosiphonic, 25 to 50 mm. high, with numerous suberect branches given off from main stem. Stem and branches more or less zigzag, with 3 to 5 rings above origin of each pedicel. Pedicels short, ringed, with 3 to 5 annulations, or with central part smooth, and with entire pedicel twice as long as hydrotheca. Hydrothecæ alternate, funnel-shaped, generally slightly constricted at level of "floor" which is some distance above base and somewhat oblique. Margin everted, not toothed, but uneven. Gonothecæ long, slender, urn-shaped, with an everted neck. Pedicel with 3 to 5 rings, upper part of capsule with faint, not prominent rings. Gonothecæ 2.5 times as long as the hydrothecæ. Several medusæ in each. Parramatta River, Australia.

Obelia andersoni Hincks.

Obelia andersoni, Hincks, 1887, Journ. Linnean Soc. London, vol. 21, p. 132, plate 12, figs. 2–4.—Thornely, 1905, Roy. Soc. London, Report on Pearl Oyster Fisheries of Gulf of Manaar, Ceylon, part 2, p. 113.

Stems nearly straight with alternate pedicels; annulated at points of origin of pedicels and above them. Pedicels ringed throughout with 7 to 8 rings. Upper three-fourths of calycle cylindrical and lower one-fourth conical. Calycle expands slightly near orifice. Rim has 10 to 16 narrow, high, bluntly pointed teeth.

The gonothecæ arise from main stem near base of pedicels and are borne on short-ringed stalks; narrow at base, expanding upwards, truncate at top. Medusæ are produced. Found on *Nellia oculata*, in the Mergui Archipelago off the coast of Tenasserim. The peculiar conical lower part of the calycle is characteristic.

Genus TIAROPSIS L. Agassiz, 1849.

Thaumantias, Sars, 1835, Beskriv og Jagttag., p. 26, taf. 5, fig. 12.
Thaumantias (in part), Forbes, 1848, British Naked-eyed Medusæ, p. 45.
Tiaropsis, Agassiz, L., 1849, Mem. Amer. Acad., vol. 4, p. 289; 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 308, 355.—Agassiz, A., 1865, North Amer. Acal., p. 69.—Haeckel, 1879, Syst. der Medusen, p. 178.—Linko, 1900, Traveaux de la Soc. Imp. des Nat., St. Pétersbourg, tome 29, p. 155.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, p. 29.—Browne, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 773.
Tiaropsedium, Torrey, 1909, University California Publications, Zool., vol. 6, p. 19.

A medusa belonging to this genus was first described by Sars, 1835, under the name *Thaumantias multicirrata*. In 1849, L. Agassiz founded for it the genus *Tiaropsis*, the best-known species of which is *Tiaropsis diademata* of the New England coast, although the type species is *T. multicirrata* of the northwestern coasts of Europe.

GENERIC CHARACTERS.

Eucopidæ with 8 marginal sense-organs, 2 in each quadrant. Each sense-organ consists of an entodermal ocellus and an open fold of velum, which contains a number of ectodermal concretions. No cirri. The 4 gonads are developed on the 4 radial-canals. The manubrium is set upon a short peduncle.

The ocelli in *Tiaropsis* are situated within the entoderm of the circular canal. Each ocellus consists of a cup-shaped mass of densely pigmented cells, the cavity of the cup being filled with unpigmented protoplasm. The concavity of the eye is directed centripetally, as if the eye were designed to see objects within the bell. Just below each ocellus is a large, pocket-like, open fold of the velum within the cavity of which are a number of ectodermal concretions, which are innervated by subumbrella or lower nerve-ring.

The sense-organs of *Tiaropsis* are strikingly like those of *Mitrocoma*, but are more complex in that they are provided with an entodermal eye, which is lacking in *Mitrocoma*.

Figures showing sections of the sense-organs of *Mitrocoma* have been given by O. and R. Hertwig, 1878 (Nervensyst. der Medusen, taf. 7, fig. 14) and by Maas (1895, Ergeb. der Plankton Expedition, taf. 6, fig. 5). A cross-section of the sense-organ of *Tiaropsis* has been given by A. Linko, 1900 (Trav. de la Soc. Impériale des Nat., St. Pétersbourg, tome 29, p. 154, plate 29, fig. 5).

The species of *Tiaropsis* are widely distributed, being found both in the Atlantic and Pacific, and in tropical as well as temperate regions; but they are seen only near coasts and are not creatures of the open ocean. There are two cohorts of the genus, one with many and the other with few tentacles.

Tiaropsis diademata L. Agassiz.

Plate 31, fig. 11; plate 32, figs. 8 and 9.

Tiaropsis diademata, Agassiz, L., 1849, Mem. Amer. Acad., vol. 4, p. 289, plate 6, figs. 1–16; plate 8, fig. 11.—Mörch, 1857, Beskriv af Grönland.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 308, 355; figs. 45–48 in text, also plate 31, figs. 9–15.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 93, fig. 10; 1865, North Amer. Acal., p. 69, figs. 91–93.—Haeckel, 1879, Syst. der Medusen, p. 178.—Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 168, plate 7, fig. 23.—Linko, 1900, Trav. de la Soc. Impériale des Nat., St. Pétersbourg, tom. 29, p. 154, planche 29, figs. 3*a-b*.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 381, fig. 100.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 49, 1 fig.

Adult medusa (plate 31, fig. 11).—Bell about 15 mm. in diameter, flatter than a hemisphere. Sides sloping, gelatinous substance of only moderate thickness. Tentacles very numerous (150 to 200), short and slender, with well-developed basal bulbs. 8 adradial marginal sense-organs, 2 in each quadrant; each consists of an entodermal mass of pigment, below which are 5 to 7 concretions contained in an open fold of the velum. The pigmented ocellus is situated within the entoderm upon the inner sides of the circular vessel; the concretions are ectodermal and inclosed within an open fold of velum (see Linko, 1900, p. 155, plate 29, fig. 5). Velum well developed. There are 4 straight, narrow, radial tubes, and a simple, slender, circular vessel. Stomach short and provided with 4 prominent crenated lips. There is a shallow peduncle with widely flaring sides. The 4 gonads are linear and developed upon the 4 radial tubes. They do not extend to the circular vessel, nor do they reach the manubrium.

Entoderm of tentacle-bulbs and of stomach ocher-yellow. Gonads are cream-colored.

Young medusa.—In the young medusa the bell is higher than a hemisphere and there is a slight apical projection. The bell-walls are thin and tentacles much less numerous than in the adult. The tentacles are covered with long, oval-shaped nematocyst-capsules that give their surfaces a bristling appearance. There are 8 marginal sense-organs in medusæ that have only 24 tentacles and are only 2 mm. wide and 3 mm. high. Tentacles increase greatly in number, while sense-organs remain constant. Manubrium of young medusa is a simple, urn-shaped tube having 4 prominent lips. During process of development bell becomes relatively

Plate 32.

Figs. 1 to 3. *Clytia volubilis*, found growing upon the stems of *Eudendrium* in tide-pools near the Agassiz Laboratory, Newport, Rhode Island, July 20, 1895. Figure 1′ shows the natural size of the hydroid shown in figure 1; figure 2, one of the calycles; figure 3, one of the gonangia showing medusa-buds. See page 262.

Fig. 4. *Clytia volubilis*. Drawing of a medusa immediately after its escape from the gonangium of the hydroid shown in figure 1.

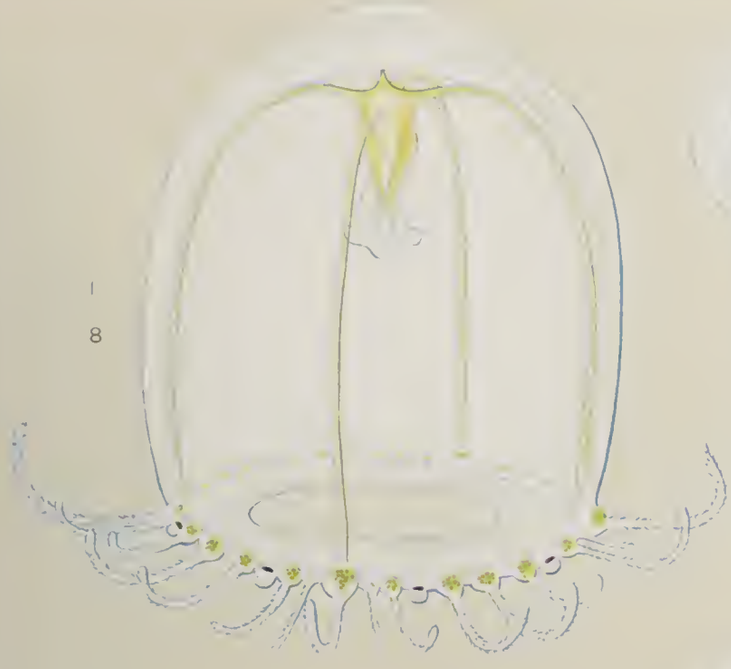
Fig. 5. *Clytia volubilis*, from a young medusa found in the ocean at Newport, Rhode Island, June, 1892.

Fig. 6. *Clytia volubilis*, half-grown medusa from Newport, Rhode Island, June, 1892.

Fig. 7. *Clytia volubilis* (?). Charleston Harbor, South Carolina, September 8, 1897.

Figs. 8 and 9. *Tiaropsis diademata*, young medusa. Nahant, Massachusetts, March 25, 1897. Figure 9 shows one of the marginal sense-organs.

Drawn from life, by the author.



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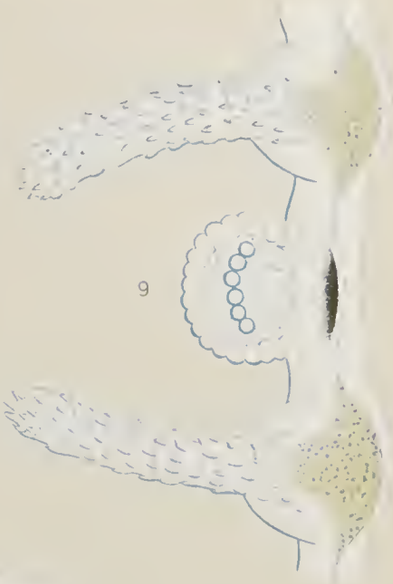

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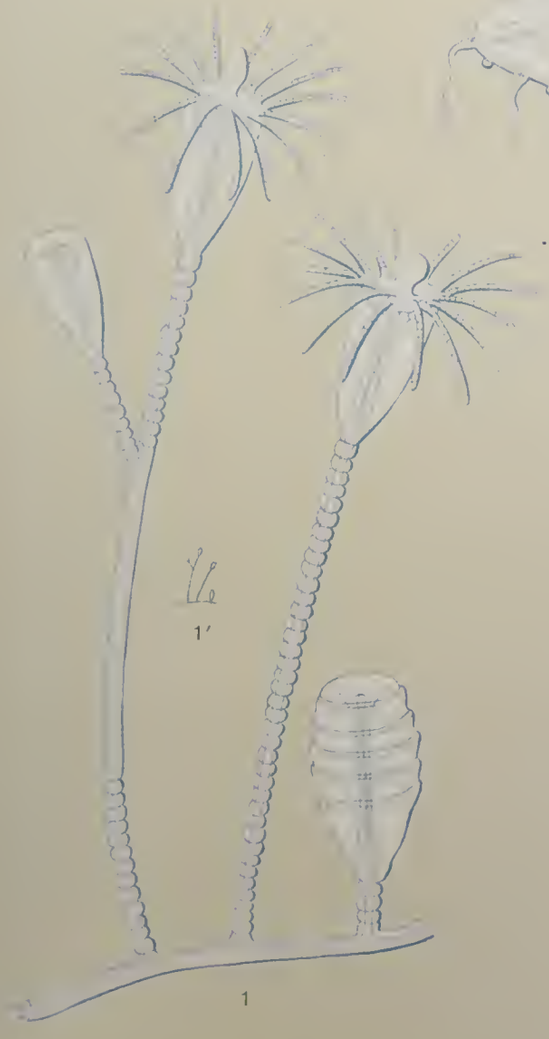

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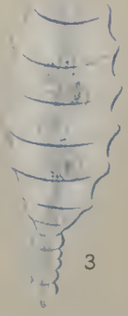


3

much flatter and broader, tentacles increase greatly in number, and gonads develop upon the 4 radial-canals.

This medusa appears in vast numbers along the coast of New England in March. It develops very rapidly and spawns in April and May. After the middle of May it becomes very rare and is not seen during the summer months. The hydroid stock is unknown. Linko records this medusa from the White Sea, northern Russia.

Tiaropsis multicirrata L. Agassiz.

Thaumantias multicirrata, Sars, 1835, Beskriv og Jagttag., Bergen, p. 26, plate 5, fig. 12 *a–c*.
Thaumantias melanops, Forbes, 1848, British Naked-eyed Medusæ, p. 45, plate 10, figs. 3 *a–d*.
Tiaropsis scotica, Allman, 1871, Monog. Tubularian Hydroids, p. 140, fig. 57.—Böhm, 1878, Jena. Zeitschrift für Naturw., Bd. 12, p. 183, taf. 2, fign. 15–30.
(??) *Tiaropsis oligoplocama*, Romanes, 1876, Journal Linnean Society London, vol. 12, p. 525; vol. 13, plate 15, fig. 4.
Tiaropsis multicirrata, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 355.—Haeckel, 1879, Syst. der Medusen, p. 179.—Browne, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 278; 1896, Proc. Zool. Soc. London, p. 481; 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 773.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 151 (citation of all literature 1835–1850).

This medusa is distinguished from the American *T. diademata* by the black entodermal pigment of its tentacle-bulbs.

Bell 20 to 30 mm. wide, 10 to 15 mm. high, with thick gelatinous walls and smoothly rounded surface. 200 to 300 short tentacles about one-fourth to one-third as long as bell-diameter. There is a small mass of black entodermal pigment constituting an "ocellus"(?) in base of each tentacle-bulb. There are 8 adradially placed marginal sense-organs, each composed of an entodermal ocellus, and a crescentic chain of about 13 spherical concretions arranged in a line in an open fold of the well-developed velum. There are 4 straight radial-canals. The manubrium lacks a peduncle and has 4 folded, recurved lips. It is 4-sided and about half to a third as long as depth of bell-cavity. The 4 gonads are linear, folded, and occupy about three-fourths of the lengths of the 4 radial-canals, extending closer to bell-margin than to sides of manubrium. Entoderm of gonads, stomach, and bell-margin dull-yellow. Ocelli and pigment of tentacle-bulbs black. Found off the coasts of England, Scotland, Helgoland, and Norway near Bergen. Hydroid unknown.

Browne, 1905, describes the young medusa, 1 mm. wide, from the Firth of Clyde, Scotland. Bell-walls thin, bell-shaped, with 24 tentacles, 8 adradial marginal sense-organs, and no gonads.

This medusa appears to be relatively rare on the northwestern coast of Europe, and it has never been taken along the American coast, where the genus is represented by the exceedingly common *T. diademata*.

Tiaropsis macleayi von Lendenfeld.

Tiaropsis macleayi, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 605, plate 32, fig. 37.

Bell 12 mm. wide and 5 mm. high, somewhat flatter than a hemisphere, evenly rounded. About 100 slender tentacles, not as long as bell-diameter. A few of these tentacles have each a basal ocellus. 8 large adradial lithocysts with concretions situated between folds of inner wall of lithocyst sac. Stomach quadrangular, prismatic, about one-third as long as depth of bell-cavity. 4 very small lips. Gonads linear, upon proximal two-thirds of the 4 radial-canals. Medusa light rose-colored. Gonads dark-red. Tentacle-bulbs and entoderm of stomach brown. Tentacles nearly colorless. Found rarely at Port Jackson, New South Wales, Australia, from April to July.

Von Lendenfeld studied the early segmentation stages of the eggs of this medusa and finds that the cell division is irregular and quite similar to that of *Geryonia*.

Tiaropsis davisii Browne.

Tiaropsis davisii, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 281.

Bell conical with moderately thick walls, 11 mm. wide, 8 mm. high. About 80 tentacles, 8 fairly large adradial sense-organs, each probably containing several concretions. Stomach short, cross-shaped when contracted. Gonads form a thin, narrow band, extending nearly whole length of the 4 radial-canals but not touching either margin or stomach. Found at Stanley Harbor, Falkland Islands.

Tiaropsis rosea Agassiz and Mayer.

Plate 31, figs. 1–4.

Tiaropsis rosea (young), Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 168, plate 7, figs. 21, 22.
Tiaropsis punctata, Mayer, 1900, *Ibid.*, vol. 37, p. 49, plate 22, figs. 60–63; 1904, Mem. Mus. Brooklyn Inst. Arts and Sci., vol. 1, p. 14, plate 3, fig. 21.
Tiaropsis rosea, Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 30, taf. 7, fign. 45–47.
Tiaropsis diademata, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 277, plate 7, figs. 13, 14.

Mature medusa.—Based on the description of a specimen by Maas, 1905, from Damar, Malay Archipelago. Bell about 15 mm. wide and flatter than a hemisphere. There are 4 well-developed, perradially situated tentacles, with large, conical basal bulbs, sharply offset from the lashes of the tentacles. These tentacles are shorter than bell-diameter. Besides these 4 well-developed tentacles, there are 28 short, rudimentary tentacle-bulbs, 7 in each quadrant. The 4 interradial tentacle rudiments are larger than the others. There are 4 adradial sense-organs which are similar in structure to those of other species of *Tiaropsis*. They consist of an open fold of the velum containing a row of numerous, small, ectodermal concretions. Above this pocket of the velum is a black ocellus in the entoderm of inner side of ring-canal. These adradial sense-organs, the tentacle rudiments, and large perradial tentacles are spaced at equal distances around margin. Thus in each quadrant there is a well-developed tentacle, then, as one passes around the bell, there are 2 tentacle rudiments, then a sense-organ, then 3 tentacle rudiments, another sense-organ, then, finally, 2 more tentacle rudiments, and, lastly, a well-developed perradial tentacle. There are thus 40 appendages (4 large, 28 rudimentary tentacles, and 8 sense-organs) on bell-margin, all at equal distances (9°) apart. Velum quite narrow. There are 4 straight, narrow radial-canals and a ring-canal.

Stomach urn-shaped, wide, and 4-sided at its base, but narrower at its throat. It is about half as long as depth of bell-cavity and the 4 lips have markedly folded edges. The gonads are linear and occupy somewhat more than the middle thirds of the 4 radial-canals.

Entoderm of stomach, tentacle-bulbs, and gonads ocher-yellow to dull-red. Ocelli black, other parts colorless.

A study of the medusæ at Tortugas, Florida, inclines me to believe that the tropical Atlantic and Pacific specimens are identical.

Tiaropsis mediterranea Metschnikoff, 1886, from the Mediterranean, is closely allied to the tropical Atlantic and Pacific species, but is apparently separated by the fact that it becomes mature with only 2 well-developed, perradial tentacles, while the 2 that are 90° apart from these large tentacles remain mere tentacle-bulbs. There is, however, considerable variation in the development of the tentacles as compared with the size and maturity of the medusa in specimens from Tortugas, Florida, and it is possible that future studies will show that there is but one *Tiaropsis* living in the warmer seas, and this should be called *T. mediterranea*.

Tiaropsis mediterranea Metschnikoff.

Tiaropsis mediterranea, Metschnikoff, 1866, Arbeit. Zool. Inst. Wien, Bd. 6, p. 239, taf. 22, fign. 6–8.

Bell rounded, 7 mm. wide, 5 mm. high, with thick gelatinous bell-walls. 2 well-developed tentacles with hollow, conical, basal bulbs; these are at the bases of 2 opposed radial-canals; there are 2 smaller tentacles at bases of the other 2 radial-canals. Longest tentacles about as long as bell-diameter. There are 5 small, rudimentary tentacle-bulbs in each quadrant. 8 adradial lithocysts, each with about 20 concretions, and an entodermal ocellus. 4 straight, narrow radial-canals with 4 linear gonads on their distal two-thirds. Manubrium conical, 4-sided with 4 short, simple lips, not reaching to level of velar opening. Entoderm yellow. Messina, Italy, in December.

Genus COSMETIRA sensu Hartlaub, 1909.

Cosmetira, Forbes, 1848, British Naked-eyed Medusæ, p. 42.—Hartlaub, 1909, Zoolog. Anzeiger, Bd. 34, p. 83.

The old genus *Cosmetira* is synonymous with *Laodicea*, but Hartlaub, 1909, defines it in a new sense to designate a medusa which was probably described by Forbes under the name *Thaumantias pilosella*.

GENERIC CHARACTERS.

Eucopidæ with 8 adradial, open lithocyst-sacs each containing numerous concretions. With 2 sorts of tentacles, hollow marginal tentacles with swollen basal bulbs provided with ocelli, and small solid cirrus-like tentacles that arise from the exumbrella as well as from the bell-margin. 4 radial-canals. No peduncle. No excretory papillæ.

Cosmetira pilosella Hartlaub.

Thaumantias pilosella, Forbes, 1848, British Naked-eyed Medusæ, p. 42, plate 8, fig. 1.
Cosmetira pilosella, Hartlaub, 1909, Zoolog. Anzeiger, Bd. 34, p. 82, fign. 1–4.
Eucheilota pilosella, Browne, 1896, Proc. Zool. Soc. London, pp. 481, 484, plate 16, figs. 7, 7a,

Hartlaub rightly believes this medusa to be identical with *Thaumantias pilosella* Forbes, 1848; and he gives a very complete description of it based upon the study of 8 specimens from the Fjords of Norway.

Bell 20 mm. wide, moderately rounded, without a true peduncle. About 64 short, hollow tentacles with swollen basal bulbs arise from the bell-margin. These tentacles are regularly bestrewn with nettle-cells and there is a dark purple ocellus on the exumbrella above the base of each of the older tentacles. There are about 6 short, straight, solid, cirrus-like tentacles upon the bell-margin between each 2 of the large tentacles. These lack basal bulbs and have no ocelli and their nettle-cells are arranged in rings around them. These solid tentacles are hardly longer than the basal bulbs of the hollow tentacles. It is most remarkable, however, that these cirrus-shaped tentacles arise not only from the bell-margin but they project also from the peripheral third of the surface of the exumbrella. Most of these exumbrella cirri are still connected with the ring-canal by narrow peronial strands, but these are often obliterated. There are 8 adradial, open lithocyst-sacs, but Hartlaub was unable to determine the number of concretions, but Gosse, 1853, who seems to have observed this medusa, states in his "Naturalist's Rambles on the Devonshire Coast" that there are 35 to 50 in each sac, but Brown, 1896, finds only 12. There are no excretion papillæ and no marginal warts, and the velum is quite broad. 4 narrow, straight radial-canals. Stomach small, 4-sided, and with 4 well-developed, folded lips. 4 perradial, ciliated furrows in the exumbrella floor of the stomach. The 4 narrow linear gonads are upon the radial-canals leaving both ends free. Stomach and gonads reddish-purple, tentacle-bulbs purple with yellow center.

Fig. 134a.—*Cosmetira pilosella*, after Hartlaub, in Zool. Anzeiger.

Gosse found that when this medusa was disturbed by touching it with a stick at night the ocellus-like spots above its tentacle-bulbs glowed suddenly with great brilliancy. Northern coasts of Europe, England to Norway.

Subfamily PHIALINÆ.

Eucopidæ with other than 8 lithocysts; manubrium with a short flaring peduncle.

Genus CLYTIA Lamouroux, 1812, in part, sens. Hincks, 1868.

Clytia, Lamouroux, 1812, Nouv. Bull. des Sci. par la Soc. philomantique, tome 3, année 5, No. 63, p. 184; 1816, Hist. des Polypiers coralligènes, Caen, p. 202.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 354.—Agassiz, A., 1865, North Amer. Acal., p. 78.—Van Beneden, 1866, Fauna Littoral de Belg., p. 165.—Hincks, 1868, British Hydroid Zoophytes, vol. 1, p. 140.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 436; *Ibid.*, 1905, tome 13, p. 60.
Eucope (in part), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 241 (young medusæ).
Epenthesis, McCrady, 1857, Gymn. Charleston Harbor, p. 191.—Haeckel, 1879, Syst. der Medusen, p. 182.—Browne, 1896, Proc. Zool. Soc. London, p. 487.

The type species is *Clytia volubilis* Lamouroux, 1812, previously described by Ellis and Solander, 1786, as *Sertularia volubilis*.

Alder, 1858, renamed this species *Clytia johnstoni* in order to disitnguish it from *Campanularia volubilis*. It is a widely-distributed form and is found along the Atlantic coasts of Europe as well as in the Mediterranean. *Clytia bicophora* Agassiz, of America, is apparently identical with the European *C. volubilis*; and *Eucope campanulata* and *E. affinis* of Gegenbaur are apparently only stages in the growth of the medusa of *C. volubilis*.

Calkins, 1899, finds a hydroid from Puget Sound, Pacific coast of America, which is apparently identical with *C. bicophora* = *C. volubilis*; and if this be true, *C. volubilis* is probably widely distributed over the temperate coasts of the northern hemisphere.

GENERIC CHARACTERS.

Eucopidæ with 16 tentacles alternating with 16 vesicular, closed lithocysts. 4 sac-like gonads upon the 4 simple radial-canals. No well-developed peduncle. No cirri. The hydroid is *Clytia*, closely related to *Campanularia*, but distinguished by its free-swimming medusæ.

When set free from the reproductive calycle of the hydroid, the medusa has 8 adradial lithocysts and a high, dome-like bell. As growth proceeds the lithocysts become 16 in number and the bell becomes flatter than a hemisphere.

There are a number of closely related species of *Clytia* which produce medusæ, but the free-swimming or adult medusa is not known and therefore no description of them appears in this text. Such species are:

Clytia geniculata Thornely, 1905, Roy. Soc. London, Report Ceylon Pearl Oyster Fisheries, vol. 2, p. 112, plate 3, figs. 4, 4*a*; from near Ceylon.

Clytia fragilis Congdon, 1907, Proc. American Acad. Arts and Sci., vol. 42, p. 470, fig. 13. Bermuda Islands.

Clytia simplex Congdon, *Ibid.*, p. 471, figs. 14, 15. Bermuda.

For *Clytia bakeri* Torrey see *Eucheilota bakeri* in the appendix.

Clytia volubilis Lamouroux.

Plate 32, figs. 1–7.

EUROPEAN SYNONYMS.

Sertularia volubilis, ELLIS AND SOLANDER, 1786, Nat. Hist. Zooph., p. 51, No. 22, plate 4, figs. *e*, *f*, E, F.

Clytia (*Sertularia*) *volubilis*, LAMOUROUX, 1812, Nouv. Bullet. Sci. par la Soc. philomantique, tome 3, p. 181.

Clytia volubilis, LAMOUROUX, 1816, Hist. des Polypiers Zooph., Caen, p. 202; 1821, Exposition méthodique genres Polypiers, p. 13, plate 4, figs. *e*, *f*, E, F (after Ellis and Solander); 1824, Encyclopédie méthodique, tome 2, p. 202, Paris.—BEDOT, 1901, Revue Suisse de Zool., tome 9, p. 436; *Ibid.*, tome 13, p. 60 (literature, 1786–1850).

Campanularia volubilis, JOHNSTON, 1832, Trans. Nat. Hist. Soc., Northumberland, Durham, and Newcastle-upon-Tyne, vol. 2, p. 255; 1838, Hist. British Zoophytes, p. 154, fig. 17.—VAN BENEDEN, 1847, Bull. Acad. Sci. Belgique, tome 14, p. 457, fig. 7 (medusa).

Campanularia johnstoni, ALDER, 1848, Trans. Tynes. Nat. F. Club, 1858, vol. 5, p. 126, plate 2, fig. 8.—ALLMAN, 1871, Monog. Tubularian Hydroids, part 1, p. 23, fig. 2.

Clytia johnstoni, HINCKS, 1868, Hist. British Hydroid Zooph., vol. 1, p. 143, plate 24, fig. 1 (hydroid and medusa).—RUFFORD, 1902, Notes on British Zoophytes, p. 53, fig. 11 (edited by E. Connold).

Eucope campanulata + *E. affinis*, GEGENBAUR, 1857, Zeit. für wissen. Zool., Bd. 8, pp. 243, 244.

Eucope affinis, METSCHNIKOFF, 1880, Zool. Anzeiger, Jahrg. 3, p. 261 (digestive cells are amœboid).

AMERICAN SYNONYMS.

Clytia bicophora, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 304, 354, plate 29, figs. 6–9.—AGASSIZ, A., 1865, North Amer. Acalephæ, p. 78, figs. 108–111.—NUTTING, 1901, Bull. U. S. Fish Commission, vol. 19, p. 343, fig. 21 (hydroid).

Clytia johnstonii = *C. bicophora* = *C. uniflora*, VERRILL, 1873, Report Commis. Fish and Fisheries for 1871–72, p. 725.

Clytia cylindrica, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 307, fig. 41.

Clytia johnstoni, CLARKE, 1876, Exploration of Alaska, vol. 1, p. 8, plate 3, fig. 12 (from Alaska).

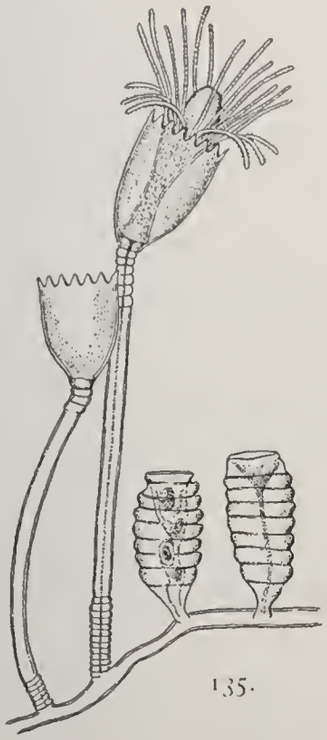
Epenthesis bicophora, HAECKEL, 1879, Syst. der Medusen, p. 184.

Epenthesis folleata, FEWKES, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, No. 8, p. 298, plate 1, figs. 10–14.

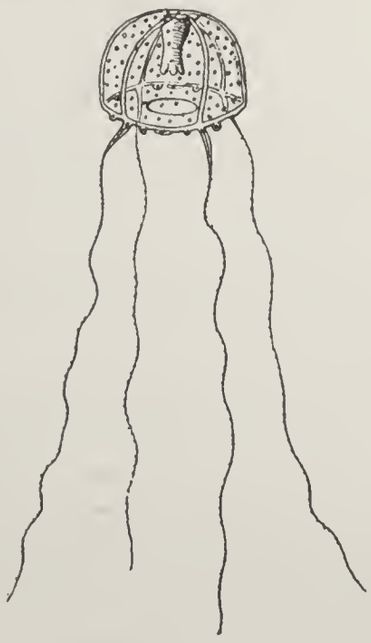
Campanularia johnstoni, CALKINS, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 348, plate 1, figs. 6–6*c*; plate 6, fig. 6D (hydroid from Puget Sound, Pacific coast).

I can not detect any specific difference between the European *Clytia volubilis* Lamouroux and the American *Clytia bicophora* Agassiz. The following description is based upon a study of the American medusa and its hydroid.

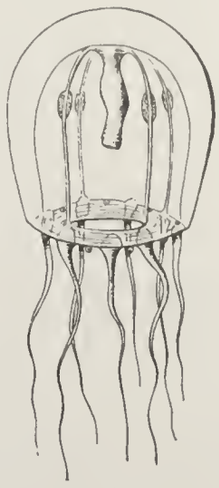
Adult medusa.—Bell about 5.5 mm. in diameter. It is about 3 times as broad as high; sides flare outward. 16 slender tentacles with well-developed basal bulbs. 16 lithocysts, each containing a single concretion, alternate with tentacles. Velum well developed. There are 4 straight, narrow radial-canals and a slender circular vessel. Manubrium short with 4 slightly recurved lips. Gonads at middle points of the 4 radial-canals, spindle-shaped, and about one-fourth as long as the radial tubes upon which they are developed. More or less brown pigment is found in the entoderm of the tentacle-bulbs, manubrium, and gonads; all other parts of the medusa are transparent.



135.



136.



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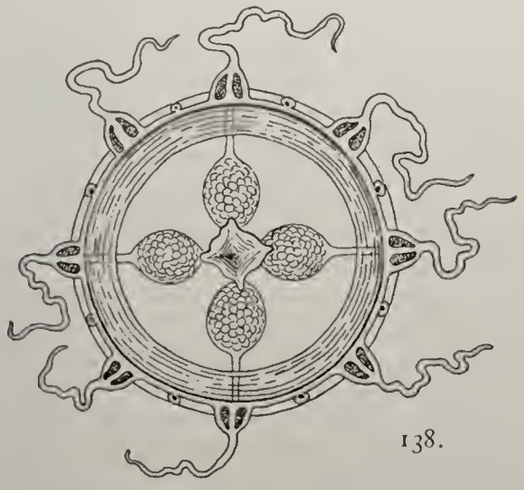
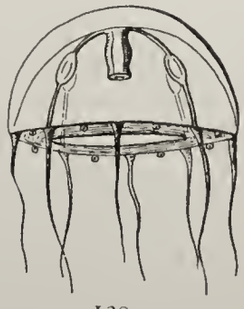


138.



139.

FIG. 135.—Hydroid of *Clytia johnstonii*, after Hincks, in British Hydroid Zoophytes.
FIG. 136.—Young medusa of *Clytia johnstonii*, after Hincks, in British Hydroid Zoophytes = *Clytia volubilis*.
FIG. 137.—"*Eucope campanulata*," after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8 = *Clytia volubilis*.
FIG. 138.—"*Eucope campanulata*," after Haeckel, 1879.
FIG. 139.—"*Eucope affinis*," after Gegenbaur, in Zeit. für wissen. Zool. = *Clytia volubilis*.

Hydroid and young medusa.—The hydroid stock is "*Clytia bicophora*" L. Agassiz (plate 32, fig. 1), which is in all probability specifically identical with *Clytia johnstonii* Hincks = *C. volubilis* Lamouroux. The hydroid is quite common in shallow tide-pools along the New England coast, where it is found attached to sea-weeds or to stems of other hydroids. The

main stem is stolonic and tortuous, and the branches that spring at right angles from it give rise to the polypites and reproductive calycles. These side branches or pedicels rarely give rise to secondary branches. They are about 5 to 8 mm. in length, always ringed at base and tip. The middle region also is sometimes ringed. The hydrothecæ are bell-shaped and quite large, and their rims display 10 to 14 triangular teeth. The polypites have 15 to 20 long, slender tentacles; the mouth is at the end of a well-developed proboscis. The reproductive calycles usually arise from the stolon, but occasionally they bud out from the sides of the pedicels of the polypites. They are borne upon a short, ringed stem, are large and ovate, and display about 7 strongly-marked, transverse rings. Each calycle gives rise to 4 or 5 medusæ. At the time of liberation the medusa is about 0.75 mm. in diameter. Bell higher than broad, and outer surface sprinkled over with nematocyst-cells. 4 equally developed tentacles at bases of the 4 radial-tubes, and 4 rudimentary, interradial tentacles. 8 lithocysts upon sides of interradial tentacles, each interradial tentacle being flanked by a pair of lithocysts. At the time of liberation the gonads are already apparent upon the 4 radial-tubes (plate 32, fig. 4). As development proceeds the bell becomes relatively much flatter and broader and the tentacles increase until they number 16.

This species is very abundant upon the northern coasts of Europe and upon the New England coast of North America. It is very rare at Charleston, South Carolina, and has not been seen at the Tortugas, Florida. Calkins records a similar hydroid from Puget Sound, Pacific coast of North America.

The young medusa is readily distinguished from the young of *Phialidium languidum* A. Agassiz, for in the young *Phialidium* there are but 2 well-developed tentacles (plate 32, fig. 4), while in *E. bicophora* there are 4. Moreover, in the young *Phialidium* the lithocysts flank the radial tentacles, while in *C. volubilis* they are situated upon both sides of the interradial tentacles. Also the young *Phialidium* shows no trace of the gonads, while in *E. bicophora* they are quite apparent in most individuals immediately after liberation from the hydroid calycle. The mature *C. volubilis* is much smaller than *P. languida*, tentacles are less numerous, and the bell is flatter. The gonads are also smaller than in *P. languida*.

Clytia folleata.

Plate 31, figs. 9, 10; plate 33, figs. 1–3.

Epenthesis folleata, McCrady, 1857, Gymn. Charleston Harbor, p. 89.
Oceania folleata, Agassiz, A., 1865, North Amer. Acal., p. 70.
Epenthesis folleata, Haeckel, 1879, Syst. der Medusen, p. 184.—Brooks, 1882, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 138 (hydroid and medusa).—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 52, plate 41, fig. 139; 1901, Sci. Bulletin Museum Brooklyn Inst. Arts and Sci., vol. 1, pp. 7, 18, plate 1, figs. 1, 7; 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, p. 15, plate 3, figs. 16, 16*a*.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 381, fig. 101.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 50, plate 5, fig. 3.
(?) *Clytia polynesiæ*, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 167, plate 6, fig. 20.

Bell hemispherical or slightly flatter; about 5 mm. wide, with thin walls. 16 flexible, highly contractile tentacles with hollow, tapering basal bulbs; the tentacles are equally spaced around the margin, 4 of them being at the ends of the 4 radial-canals, and 3 in each of the 4 interradial quadrants. Tentacles slightly less than length of bell-radius when expanded. 16 closed marginal lithocysts, each containing a single spherical concretion. These alternate in position with the 16 radial-canals. Velum well-developed. 4 straight, narrow radial-canals and a simple slender ring-canal. Manubrium only about half as long as depth of bell-cavity, with 4 simple, slightly recurved lips. No gastric peduncle. The 4 gonads are swollen and oval and developed on the outer one-fourth to one-third of the radial-canals very near the ring-canal. Entoderm of stomach, gonads, and tentacle-bulbs green.

This medusa is abundant along the coast of North America from Cape Hatteras, southward to the West Indies. It is found off the southern coast of New England in summer and is most abundant at Tortugas, Florida, in spring, and practically disappears before August. It is identical in appearance with *Clytia polynesiæ* Agassiz and Mayer, of the Fiji Islands, South Pacific.

Young medusa.—In the young medusa, 1 mm. in diameter, the 4 radial tentacles are well developed, while the 4 interradial ones are less so, and the 8 others still less. 16 lithocysts, as in the adult. Gonads spherical and situated at middle points of the 4 radial tubes. Bell much more hemispherical than in adult.

PLATE 33.

Fig. 1. *Clytia folleata*, mature female. Great Salt Bank, Anguilla Cay, Bahamas, February 25, 1893.

Fig. 2. *Clytia folleata*, young medusa caught in the same tow with the medusa represented in figure 1. The gonads are still migrating outward along the radial-canals.

Fig. 3. *Clytia folleata*, mature male. Tortugas, Florida, June, 1898.

Figs. 4 and 5. *Phialidium languidum*, successive stages in the growth of the young medusa. Agassiz Laboratory, Newport, Rhode Island, July, 1892. See page 269.

Fig. 6. *Phialidium languidum*, mature male. Eastport Harbor, Maine, August 14, 1897.

Figs. 7 and 8. *Phialidium languidum* (southern form). Mature female. Tortugas, Florida. June to July, 1897–98. Figure 8, part of the bell-margin of the medusa represented in figure 7.

Figs. 9 to 11. *Phialidium discoidum*. Successive stages in the growth of the medusa. Figure 11, part of the bell-margin of the medusa shown in figure 9. See page 272.

Drawn from life, by the author.

A. Hoen & Co

The young of this medusa are found among the Bahama Islands during the winter. We met with a great swarm of them near Anguilla Cay, Great Salt Bank, Bahamas, on February 25, 1893. McCrady, 1857, found a single specimen in Charleston Harbor, and Brooks, 1882, found both the hydroid and medusa at Beaufort, North Carolina.

Brooks identifies the hydroid stock with *Campanularia noliformis* McCrady, 1857 (Gymn. Charleston Harbor, p. 92, plate 11, fig. 4). Brooks, 1882, says the hydroid is very much like *Clytia (Platypyxis) cylindrica* Agassiz, L., 1862 (Cont. Nat. Hist. U. S., vol. 4, pp. 306, 354, figs. 42–44, p. 307). Distal end of reproductive calycle is truncated squarely instead of flaring, and the cross-section of the calycle is a circle instead of an ellipse, as in *Clytia cylindrica*. The calycle contains 4 or 5 medusæ, which are nearly equal in size each to each, and they are discharged in quick succession, the last escaping within a few minutes after the first. The tentacles and lithocysts of the young medusa are similar to those of *Epenthesis bicophora*.

Description.		Number found.
Normal medusæ with	4 radial-canals and 4 lips.	251
Abnormal medusæ with	4 radial-canals and 3 lips.	13
	4 radial-canals and 5 lips.	6
	4 radial-canals and 2 lips.	1
	3 radial-canals and 3 lips.	1
	5 radial-canals and lips lost.	1
	6 radial-canals and 4 lips.	1
Two manubria each with 3 lips and 3 canals.		1
		275

Mayer, 1901, studied the variations of this medusa, which is of interest, owing to the fact that a 5-rayed species, *Pseudoclytia pentata*, is probably derived by discontinuous variation as a mutation, either from *C. folleata* itself or some closely allied form. *C. folleata* is quite constant, as is shown by the following summary of the variations of 275 specimens found at Tortugas, Florida.

Of these 275 medusæ, 255 were radially symmetrical, and only 2 medusæ had both radial-canals and lips irregular.

Clytia universitatis Torrey.

Clytia universitatis, Torrey, 1904, University of California Publications, Zool., vol. 2, p. 19, figs. 12, 13.

Stem of hydroid more than 200 mm. long, irregularly branched, forming bushy tufts. Stem and branches polysiphonic. Pedicels of hydranths long and almost completely ringed. Hydrothecæ deep, conical, with slightly bulging sides and with 12 to 15 triangular, sharp-pointed, marginal teeth. Hydranths range in length from 0.7 to 0.83 mm. and in width from 0.37 to 0.42 mm. Hydranths have about 28 tentacles.

Gonangia club-shaped and borne on stem, branches, or hydranth pedicels. They are 0.95 to 1 mm. long and 0.39 to 0.41 mm. wide. Pedicel very short and may exhibit a single annulus. Outline of sides of gonangia somewhat wavy with one or two annulations near broad distal end. Numerous medusa-buds, the oldest of which have 4 tentacles.

San Diego Bay, coast of California.

Clytia rangiroæ.

Epenthesis rangiroæ, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. Harvard College, vol. 26, p. 145, plate 1, fig. 4.

Bell slightly flatter than a hemisphere, 7 mm. in diameter. Bell-walls thin and flexible. 16 well-developed tentacles with large, conical, basal bulbs. 16 lithocysts, each containing a single, spherical concretion, alternate in position with the 16 tentacles. Velum broad. 4 straight, slender radial-canals and a narrow circular vessel. Manubrium very short and quadratic in cross-section, 4 slightly recurved lips. The 4 gonads are found upon the 4 radial-canals very near the circular vessel. In the single specimen obtained each gonad contained 6 to 8 prominent eggs. The medusa is transparent with the exception of the manubrium, gonads, and tentacle-bulbs, which are translucent and milky in color. This form was found in the lagoon of Rangiroa Island, Paumotus, South Pacific, on September 23, 1899.

Genus PHIALIDIUM Leuckart, 1856.

Oceania (in part), Péron et Lesueur, 1809, Annal. Mus. Hist. Nat. Paris, tome 14, p. 344.
Oceania, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 352.—Agassiz, A., 1865, North American Acalephæ, p. 70.—Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, No. 9, p. 167.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, p. vol. 37, 50.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 49.
Dianæa (in part), Lamarck, 1817, Hist. Anim. sans Vertèbres, tome 2, p. 505.
Thaumantias (in part), Eschscholtz, 1829, Syst. der Acalephen, p. 79.

Phialidium, Leuckart, 1856, Archiv. für Naturges., Jahrg. 1, p. 18.—Haeckel, 1879, Syst. der Medusen, p. 185.—Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 282.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 20; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 31; 1906, Revue Suisse de Zool., tome 14, p. 91.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 485; *Ibid.*, 1905, tome 13, p. 142.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 155.

Campanulina (hydroid), Van Beneden, 1847, Bull. Acad. Sci. Belgique, tome 14, p. 457, plate 1, fig. 6.—Hincks, 1868, Hist. British Hydroid Zoophytes, p. 186.

Péron and Lesueur, 1809, instituted the genus *Oceania*, including within it medusæ which fall under the more modern genera *Clytia*, *Eirene*, *Phialidium*, *Protiara*, *Stomotoca*, *Thaumantias*, *Pandea*, and *Turris*. Thus vaguely defined the name *Oceania* soon fell into hopeless confusion, although more commonly applied to Tubularian medusæ such as *Turris* than to the Eucopidæ. In 1862, L. Agassiz reinstated the genus *Oceania*, restricting it to apply to a genus of the Eucopidæ which had previously been segregated and defined by Leuckart, 1856, under the name *Phialidium*. The name *Phialidium* thus takes precedence over Agassiz's restricted *Oceania* and must supplant it.

Following the lead of Agassiz, American authors have generally adopted the name *Oceania* in his sense, whereas European writers have followed Leuckart in calling these medusæ *Phialidium*. The type species is from the Mediterranean. It is probable that this medusa was previously described by Gronovius, 1760, under the name *Medusa hemisphærica* and should therefore be called *Phialidium hemisphæricum*.

GENERIC CHARACTERS.

Eucopidæ with 16 or more tentacles and even more numerous closed, vesicular lithocysts scattered more or less irregularly between the tentacles. Neither cirri nor permanently rudimentary tentacles. The tentacle-bulbs are simple and their entodermal cores do not project inward into the gelatinous substance of bell. 4 radial-canals, 4 gonads, manubrium without a well-developed peduncle and with 4 lips. The hydroid is *Campanulina* Van Beneden.

Phialidium is closely related to *Clytia* but in *Clytia* there are 16 tentacles alternating with 16 lithocysts, whereas in *Phialidium* the lithocysts are somewhat irregular in arrangement and always more numerous than the tentacles. Maas, 1905, institutes a subgenus, *Phialucium*, to include medusæ resembling *Phialidium*, but having some permanently rudimentary tentacle-bulbs (no cirri) upon the bell-margin, and Torrey, 1909, institutes *Phialopsis* for medusæ with marginal cirri.

Medusæ of *Phialidium* are among the most abundant hydromedusæ in all seas. They are found, however, only near coasts and are not creatures of the open ocean, for their hydroids live only in the shallow waters along the shore. Unfortunately the hydroid stocks of the various species of *Phialidium* have been strangely overlooked, and are but little known in comparison with our knowledge of their medusæ. It will be impossible to be certain of specific distinctions in the case of several members of the genus such as *P. hemisphæricum* and *P. languidum*, which may be identical, until a fuller knowledge of their hydroid phases is attained.

Phialidium hemisphæricum.

Medusa hemisphærica, Gronovius, 1760, Acta Helvetica, tome 4, p. 35, plate 4, Basileæ.

Oceania hemisphærica, Péron et Lesueur, 1809, Annal. du Muséum Hist. Nat. Paris, tome 14, p. 347.

Thaumantias hemisphærica, *T. thompsoni* (?), *T. sarnica*, *T. pileata*, *T. inconspicua*, *T. punctata*, *T. lineata*, *T. pileata*, Forbes, 1848, British Naked-eyed Medusæ, pp. 47–52, plate 8, figs. 2, 3; plate 10, fig. 1; plate 11, figs. 1, 2, 4, 5.

Thaumantias inconspicua (hydroid), Wright, 1861, Journ. Microscop. Sci. N. S., vol. 2, pp. 202, 308.

Thaumantias leucostyla, Spagnolini, 1876, Catalogo Acalefi Mediterraneo, p. 27.

Phialidium variabile (in part), Haeckel, 1879, Syst. der Medusen, p. 186 (see also p. 128).

Phialidium temporarium, Browne, 1896, Proc. Zool. Soc. London, p. 489, plate 17, figs. 4–6; 1903, Bergens Museums Aarbog, No. 4, p. 18; 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 772.

Epenthesis cymbaloides (young medusa), Haeckel, 1879, Syst. der Medusen, p. 183.

(?) *Campanularia inconspicua*, Calkins, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 349, plate 2, figs. 8–8c; plate 6, fig. 8d (hydroid from Puget Sound).

Oceania flavidula, Péron et Lesueur, 1809, Annal. Muséum Hist. Nat. Paris, tome 14, p. 345.

Clytia flavidula=*Oceania flavidula* (?), Péron et Lesueur=*Geryonia planata*, Will=*Phialidium ferrugineum*, Haeckel; see Metschnikoff, 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 241, taf. 22, fign. 9, 10, 15 (medusa from the Mediterranean).

Clytia flavidulum, Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, p. 23 (egg), pp. 35, 50 (segmentation), p. 76 (attachment), taf. 2, fign. 1–12, 21–23, 25–36; taf. 3, fign. 1–8.

Phialidium (*Clytia*) *flavidula*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 61 (found off coast of Scotland).

(?) *Thaumantias melanops*, M'Intosh, 1889, Seventh Annual Report Fishery Board of Scotland, p. 282, plate 5, fig. 5.

Browne, 1896, 1903, 1905, has made a careful revision of the species of *Phialidium* found off the British coast, basing his conclusions upon the study of living specimens. He finds that it is highly probable that *Thaumantias hemisphærica*, of Forbes and others, is in reality a *Phialidium*, which he calls *P. temporarium*. I think it would be more conservative not to change the old specific name, and therefore propose to retain the name *hemisphæricum*.

Browne also finds that the following "species" of *Thaumantias* described by Forbes are merely stages in the growth of *Phialidium hemisphæricum:*

Name.	Width.	Tentacles.	Color.
T. thompsoni.	9 mm.	16	Gonads and stomach yellow.
T. sarnica.	15 mm.	20	Gonads and stomach bluish.
T. pileata.	24±mm.	20	Gonads and stomach yellowish-brown.
T. inconspicua.	17 mm.	16 to 20	Gonads lilac to greenish, stomach yellow.
T. punctata.	18 mm.	32	Gonads and stomach purplish.
T. lineata.	24±mm.	36	Gonads and stomach yellow.
T. hemisphærica.	21 mm.	32 to 36	Gonads orange, stomach purple-pink.

Browne describes the adult medusa of *P. hemisphæricum* as being 21 mm. wide, nearly hemispherical, with thin, gelatinous walls. 30 to 39 tentacles, 1 to 3 lithocysts, usually 2, between each successive pair of tentacles. Each lithocyst is a small, closed sac containing a single spherical concretion. 4 narrow, straight radial-canals, with linear, elongate, folded, oval gonads on their outer halves, not quite touching bell-margin. Stomach short, with 4 simple lips, and without a peduncle. Gonads and stomach usually yellowish-brown, tentacle-bulbs brown or reddish-brown. Specimens found by me off Mousehole, Cornwall, England, October and November, 1907, had the tentacle-bulbs, gonads, and stomach green.

When this medusa is 0.75 mm. high and 0.75 mm. wide there are only 4 tentacles and 4 interradial tentacle-bulbs. 8 lithocysts. The 4 gonads are seen as 4 minute vesicles at the middle points of the 4 radial-canals.

When about 4 to 5 mm. wide the medusa is hemispherical, with 16 tentacles, and 16 or more lithocysts.

This medusa is exceedingly abundant off the Atlantic coasts of Northwestern Europe, and I believe it to be identical with "*Clytia flavidula*" Metschnikoff, of the Mediterranean, having seen the Mediterranean medusa alive in numerous surface-tows made at Naples by the Stazione Zoologica, during the winter of 1907–08. *P. hemisphæricum* is found throughout the year in the Firth of Clyde, Scotland, the young being found from January until April, and the adults from the end of May until autumn, when they are most numerous. The same statements may be made of our American *P. languidum* off the coast of Massachusetts north of Cape Cod.

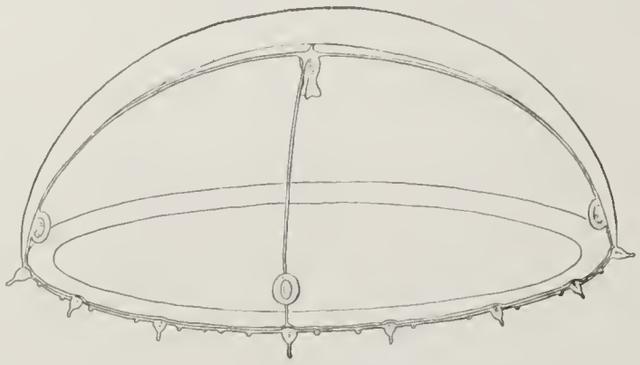
The mature hydroid is not known with certainty, but it is probably a *Campanulina* (see Hincks, 1868, p. 179). The stem is rooted by a threadlike hydrorhiza, and is simple, ringed at base and just below calycle or sometimes throughout its length. Hydrothecæ with 7 to 9 denticulations on margin. Reproductive calycles unknown. This hydroid was reared from the egg of the medusa by Wright.

Calkins, 1899, describes a very similar hydroid from Puget Sound, Pacific coast of North America.

The early development of *P. hemisphæricum=Clytia flavidula*, of the Mediterranean, was studied by Metschnikoff, 1886. He finds that the egg is about 0.26 mm. in diameter and is laid between 8 to 9 in the morning in March and April. Segmentation is total and nearly equal, and the entoderm is formed by polar ingression of cells from the hinder end of the larva. At first the one-layered larva is quite irregular in outline, but later it becomes elongated, spindle-shaped, and ciliated. Nematocysts develop in the ectoderm of its hinder end and it finally attaches itself by its forward end, which becomes the hydrorhiza, while the hinder end develops into the polyp.

The following is from Metschnikoff's description of his "*Clytia flavidula*" of the Mediterranean, and I feel assured that the medusa he refers to is identical with "*Thaumantias hemisphærica*" Forbes and *Phialidium temporarium* Browne: Bell about 15 mm. wide, flat,

shield-shaped. About 24 very small, slender tentacles with swollen basal bulbs. 50 to 70 lithocysts on bell-margin between the tentacles. Each lithocyst a closed sac with a single concretion. No cirri. 4 long, straight radial-canals, with 4 linear gonads on their outer (distal) halves. Stomach small, with 4 simple lips. No peduncle. Stomach, gonads, and tentacle-bulbs rusty, reddish-brown, yellowish, fleshy pink, milky, or green. Common throughout the year in the Mediterranean.



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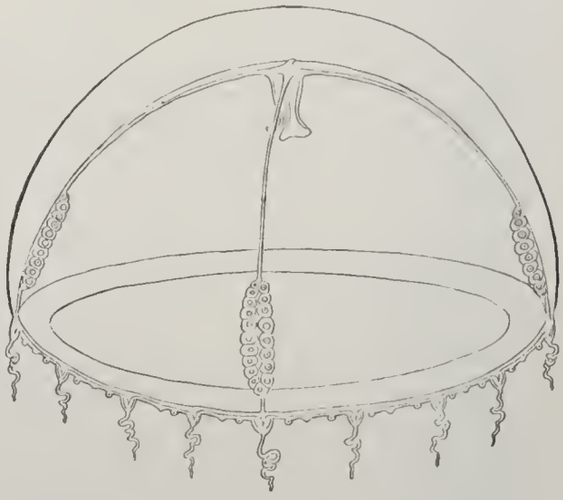

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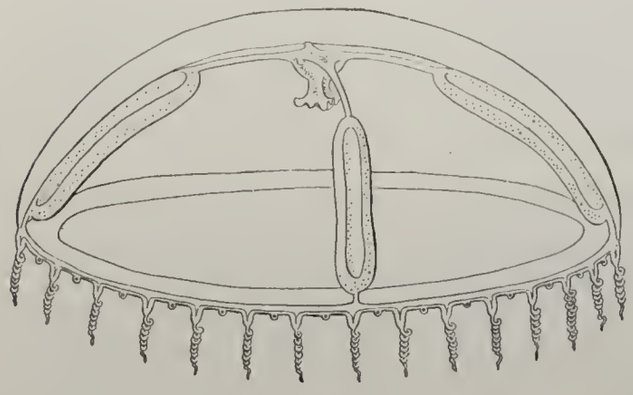

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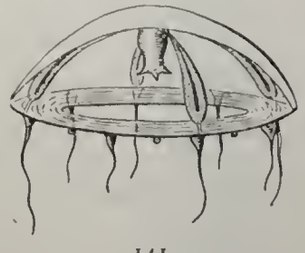

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FIG. 140.—"*Medusa cymbaloidea*," after Slabber, 1778, in Naturkundige Verlustigingen = *Phialidium hemisphæricum*.

FIG. 141.—"*Eucope thaumantioides*," after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8 = *Phialidium hemisphæricum*, half grown.

FIG. 142.—*Phialidium hemisphæricum*, from life, by the author, Zoological Station, Naples, January, 1908.

FIG. 143.—*Phialidium hemisphæricum*, from life, by the author, Zoological Station, Naples, December, 1907.

FIG. 144.—*Phialidium hemisphæricum*, from life, by the author, Mousehole, Cornwall, England, October, 1907.

Plate 34.

Figs. 1 and 1′. *Phialidium gelatinosum*, male. Figure 1′, one of the marginal lithocysts. Tortugas, Florida, June 14, 1897.

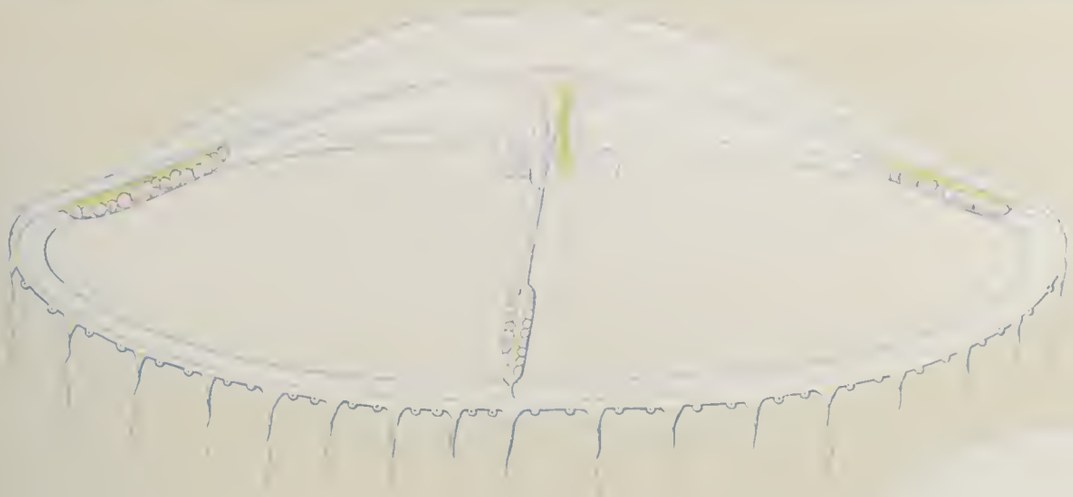
Fig. 2. *Phialidium mccradyi*, producing a generation of medusa-buds within the hydroid blastostyles upon its gonads. Nassau Harbor, Bahamas, July, 1903. Drawing uncolored.

Fig. 3. *Phialidium mccradyi*. Side view of the medusa, Tortugas, Florida.

Fig. 4. *Phialidium globulosum*. Tortugas, Florida, June 16, 1897.

Fig. 5. *Phialidium languidum* (southern form), mature female. Tortugas, Florida.

Drawn from life, by the author.



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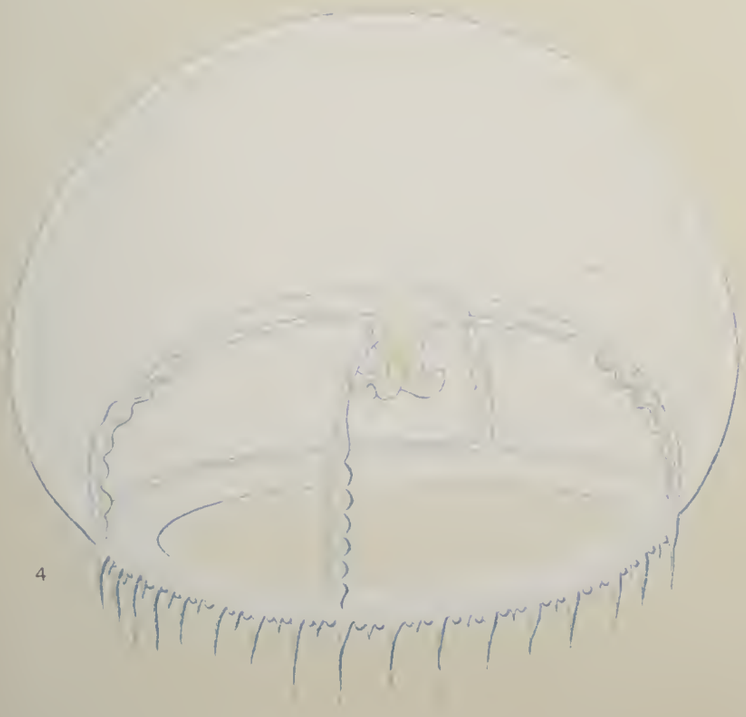

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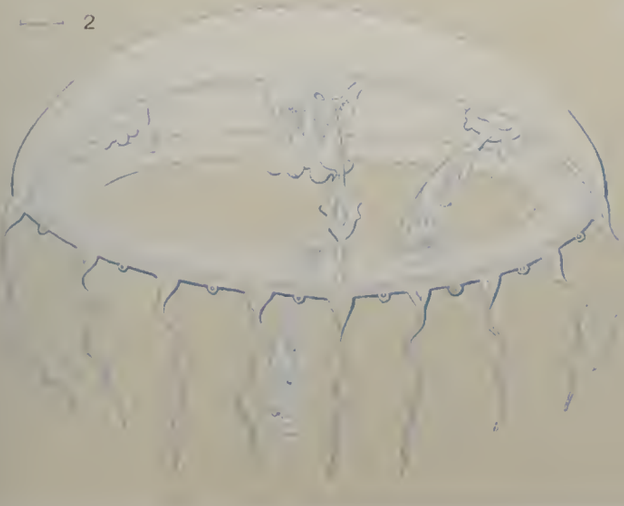

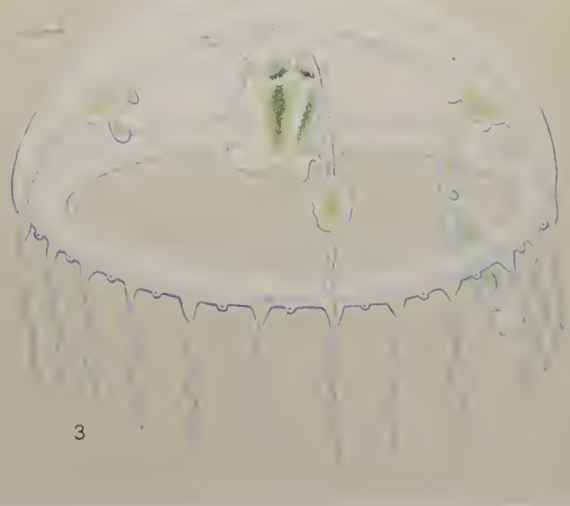

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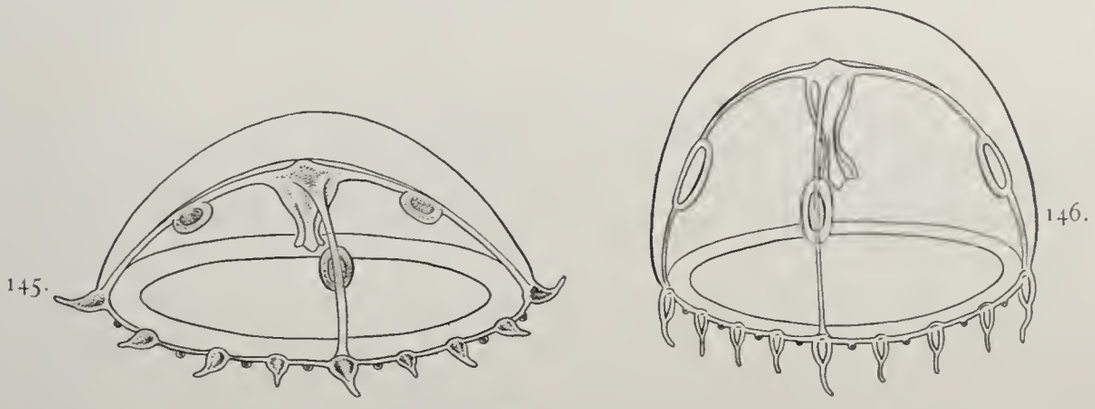
Phialidium languidum Haeckel.

Plate 33, figs. 4 to 8; plate 34, fig. 5.

Oceania languida, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 353.—Agassiz, A., 1865, North Amer. Acal., p. 70, figs. 94–102.
(?) *Campanularia syringa*, Stimpson, 1853, Marine Invertebrata of Grand Manan, p. 8.
Philalidium languidum, Haeckel, 1879, Syst. der Medusen, p. 188.
Oceania languida, Fewkes, 1884, American Naturalist, vol. 18, p. 196, fig. 3 (abnormality).—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 50, plate 5, fig. 2.
Oceania magnifica (southern variety), Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 50, plate 9, figs. 18, 18*a* (this is possibly identical with *P. flavidula*, Péron et Lesueur, of the Mediterranean).
(?) *Phialidium languidum*, Murbach and Shearer, 1903, Proc. Zool. Soc. London, vol. 2, p. 179 (Puget Sound, British Columbia).
(?) *Campanularia inconspicua*, Calkins, 1899, Proc. Boston Soc. Nat. Hist., vol. 28, p. 349, plate 2, figs. 8 to 8*c*; plate 6, fig. 8*d* (hydroid from Puget Sound).

Adult medusa (plate 33, fig. 6).—Bell somewhat flatter than a hemisphere and about 15 to 20 mm. in diameter. Bell-walls exceedingly flexible, gelatinous substance of only moderate thickness. There is a large number of short, slender tentacles, full-grown individuals usually with about 32 or more. There are usually about 2 lithocysts between each successive pair of tentacles. Each lithocyst contains a single spherical concretion. Concretions ectodermal and inclosed by cells of velum on bell-margin. Velum well developed. 4 straight, narrow radial-canals and a slender circular vessel. Manubrium small and tubular, without a peduncle, and provided with 4 slightly recurved lips. The 4 gonads are linear and developed upon the outer halves of the 4 radial-canals. They begin at about the middle point of each canal and do not quite extend to the circular vessel.



Figs. 145 and 146.—*Phialidium buskianum*, from life, by the author.
145. Zoological Station, Naples, December, 1907.
146. Mousehole, Cornwall, England, October 27, 1907.

The entoderm of the manubrium, gonads, and tentacle-bulbs is usually creamy-yellow or milky in color, all other parts of the medusa being transparent; the colors are, however, somewhat variable, the entoderm being sometimes green or pink. In a similarly formed medusa at Tortugas, Florida, the entoderm of the stomach and tentacle-bulbs is intense green and the ectoderm purple.

This medusa is remarkable for the extreme tenuity of the gelatinous substance of the bell, which becomes distorted by the contractions of the animal so as to assume all sorts of irregular, collapsed shapes. These contracted states are, however, rarely seen in medusæ freshly taken from the sea and are mainly due to the unfavorable influence of confinement in aquaria.

The hydroid stock of this medusa is *Campanulina languida*, briefly mentioned in a note by L. Agassiz, 1862 (Cont. Nat. Hist. U. S., vol. 4, p. 354), as the American species of *Wrightia*. Unfortunately no figures of it have ever been published.

In the youngest medusæ observed, plate 33, fig. 4, the bell is dome-shaped and considerably higher than it is broad. There are 2 long tentacles and 2 rudimentary ones at the bases of the 4 radial tubes. There are 8 primitive lithocysts situated close by sides of bases of the 4 primary tentacles, each tentacle-bulb being flanked by a pair of lithocysts. No gonads are to be seen in the young medusa. As development proceeds the tentacles increase greatly in number and the lithocysts keep pace with them and remain about twice as numerous as the ten-

tacles. The bell becomes relatively shallower and broader until in the adult it is flatter than a hemisphere.

This medusa is exceedingly abundant during the summer months along the New England coast. During July to September the harbor of Eastport, Maine, is crowded with these animals to such an extent that their bells nearly touch as they swim at the surface of the water. The medusa is less abundant at Newport, Rhode Island, and is rare at Charleston, South Carolina. A brilliantly colored southern variety (plate 34, fig. 5) is common at Tortugas, Florida.

Points of distinction between this form and *Clytia bicophora*, which it closely resembles, are stated in the description of *C. bicophora*.

Some of the European species of *Phialidium* appear to display a wide range of variability in number and arrangement of radial-canals, tentacles, etc., but in our *P. languidum* not more than two or three individuals in a hundred depart in any meristic manner from the normal.

I am inclined to believe that our American *P. languidum* may be identical with *P. hemisphærica*=(*Thaumantias hemisphærica* Forbes, *Phialidium temporarium* Browne), of the Atlantic coasts of Europe. The only difference appears to be that in the European medusa the stomach, gonads, and tentacle-bulbs range from yellowish to brown or orange, whereas in the American medusa they are milky, green, or pink, the usual color in our specimens from the coast of Massachusetts being dull-milky or faint yellowish-brown.

Murbach and Shearer record a medusa from Puget Sound, British Columbia, which they consider to be identical with *P. languidum*, and this opinion is rendered the more probable by the discovery by Calkins of a hydroid in Puget Sound which appears to be identical with *Campanulina*. It is possible, therefore, that our American *P. languidum* may be of circumpolar distribution.

Phialidium buskianum Browne.

(?) *Thaumantias thompsoni*, Forbes, 1848, British Naked-eyed Medusæ, p. 49, plate 11, fig. 5.
Thaumantias buskeana, Gosse, 1853, Naturalist's Rambles Devonshire Coast, p. 385, plate 22.
(?) *Phialidium variabile*, Claus, 1881, Arbeit. Zool. Inst. Wien, Bd. 4, pp. 23, 111, plate 4, figs. 34–38 (growth of the medusa).—Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 193 (common at Helgoland).—Trinci, 1907, Archiv. Ital. Anat. Embr. Firenze, vol. 5, p. 533, pl. 32–36 (development and structure of oocytes).
Phialidium variabilis, Van Rees, 1884, Tijdschrift Nederland Dierk., Ver. Suppl., Deel. 1, p. 589.
Phialidium buskianum, Browne, 1896, Proc. Zool. Soc. London, p. 488, plate 16, figs. 6, 6*a*; 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 771.

This medusa resembles *P. hemisphæricum*, but its gonads are short, swollen, and oval and are situated between the middle points of the 4 radial-canals and the bell-margin. In *P. hemisphæricum*, on the other hand, the gonads are long and linear, and developed upon the outer halves of the radial-canals. According to Claus this, or a very similar medusa, may become mature with 16 tentacles and about 20 marginal lithocysts somewhat irregularly placed between the tentacles. When 1.5 mm. wide the medusa has only 4 radially placed tentacles and 4 interradial tentacle-bulbs, the latter being flanked by 8 lithocysts, as in the young of *Clytia volubilis*. The 4 gonads appear as minute spherical vesicles peripheral to middle points of the 4 radial-canals and quite near ring-canal.

Claus found this medusa in the Mediterranean. I have seen many living specimens of it at Naples during a visit to the Stazione Zoologica in the winter of 1907–08. Medusæ similar to the above, or with as many as 20 to 32 tentacles and 25 to 60 lithocysts, are abundant off the Atlantic coasts of France, Germany, and Great Britain. They range in color from milky-white to green to rusty brown and are distinguished by their short, swollen, oval gonads near the middle of the radial-canals.

While the Atlantic and Mediterranean forms are probably identical, we can not be certain upon this point until their hydroids are discovered. I am inclined to regard *P. hemisphæricum*, and *P. buskianum* as at most mere varieties, one of the other.

A green-colored Mediterranean medusa which I consider to be identical with *P. buskianum* is described by E. Metschnikoff, 1886 (Arbeit. Zool. Inst. Wien, Bd. 6, p. 242, taf. 22, fign. 11–14, 16; Embryol. Studien an Medusen, pp. 23, 36, 52, taf. 2, fign. 13–20, 24; taf. 3, fig. 9).

Metschnikoff states that this medusa is smaller and its gelatinous substance thicker and more rigid than in *P. flavidula* (=*P. hemisphæricum*). Bell not more than 11 mm. wide. There are about 30 tentacles and 35 to 40 lithocysts on margin between tentacles. Thus there are

Plate 35.

Fig. 1. *Phialidium mccradyi.* Oral view of the medusa. Tortugas, Florida, July, 1898.

Fig. 2. *Phialidium mccradyi.* One of the hydroid blastostyles that are produced upon the gonads of the medusa.

Fig. 3. *Phialidium mccradyi.* Side view of one of the gonads.

Fig. 4. *Pseudoclytia pentata.* Side view of the medusa. For oral view of manubrium see figure 7, plate 36. Tortugas, Florida, July, 1898. See page 278.

Fig. 5. *Pseudoclytia pentata.* A tentacle-bulb of the medusa shown in figure 4.

Fig. 6. *Pseudoclytia pentata*, red variety. Tortugas, Florida, July 22, 1898.

Fig. 7. *Gastroblasta ovalis*, oral view of a medusa with 4 manubria. Tortugas, Florida, June 30, 1899. See page 281.

Fig. 8. *Gastroblasta ovalis.* Side view of a medusa with 4 manubria and 2 gonads. Tortugas, Florida, July 1, 1899.

Figs. 9 and 10. *Phialidium singularis.* Figure 3′ shows a part of the bell-margin of the medusa shown in figure 3. Agassiz Laboratory, Newport, Rhode Island, August 22, 1896. See page 273.

Drawn from life, by the author.

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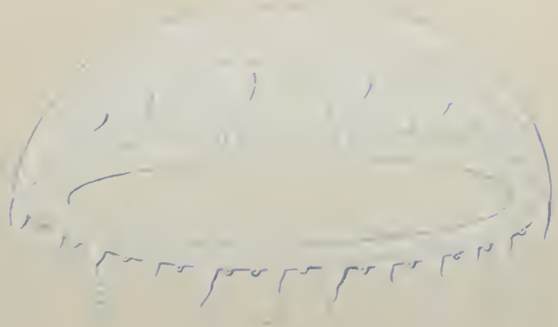

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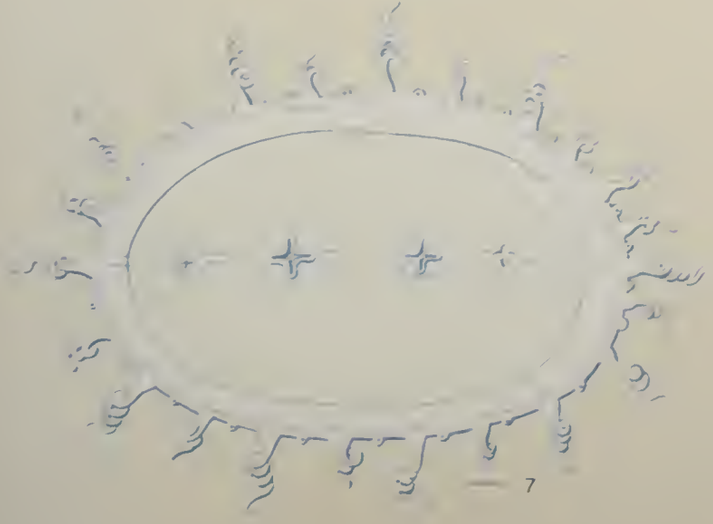

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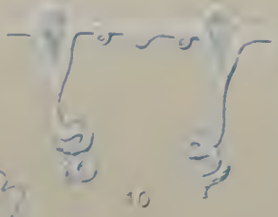

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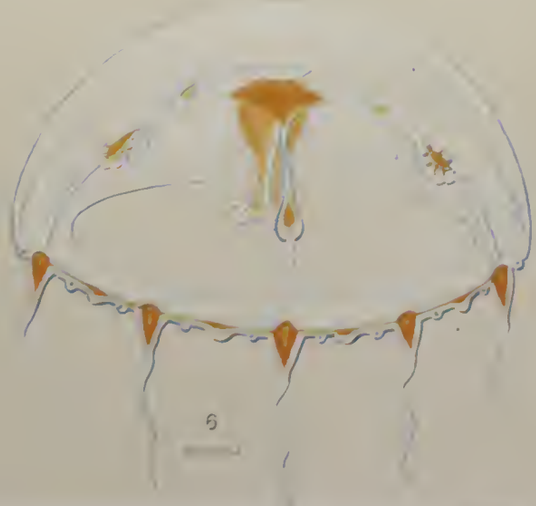

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relatively fewer lithocysts than in *P. hemisphæricum*. Stomach much larger than in *P. hemisphæricum*. There are 4 straight, narrow radial-canals with 4 short, swollen gonads on their distal outer parts. These gonads are shorter and more swollen than in *P. hemisphæricum*.

The green color of the stomach is very characteristic. The gonads and tentacle-bulbs dull yellow. Found in the Mediterranean. I have seen this medusa at Naples.

Metschnikoff studied the early stages of development of this medusa and the following is a brief abstract of his results:

The egg is 0.16 mm. wide and laid at 8 in the evening in March and April. Segmentation is total and almost equal. A one-layered, ciliated, spindle-shaped larva is formed and the entoderm is produced by cells which migrate into the segmentation cavity from its narrow hinder end. Then it attaches itself by its forward end and the hinder end grows upward into a hydroid. Unfortunately we know nothing of the full-grown hydroid, and it will be impossible to determine the various species of *Phialidium* with certainty until we acquire a fuller knowledge of their hydroid stocks.

Phialidium mccradyi.

Plate 34, figs. 2, 3; plate 35, figs. 1–3.

Epenthesis mccradyi, Brooks, 1888, Johns Hopkins Univ. Circulars, vol. 7, No. 63, pp. 29–30; 1888, Studies Johns Hopkins University Biol. Lab., vol. 4, pp. 147–162, plates 13–15.—Sigerfoos, 1893, Johns Hopkins Univ. Circ., vol. 12, No. 106, p. 106.

Oceania mccradyi, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 50, plate 21, figs. 56–59; 1904, Mem. Brooklyn Inst. Museum Nat. Sci., vol. 1, p. 15, plate 3, figs. 23, 24.

Bell very flexible and of soft consistency; about 15 mm. in diameter and shallow, about twice as broad as high. The tentacles vary in number from about 16 to about 24. There are 1 to 2 lithocysts between each successive pair of tentacles. Each lithocyst contains a single spherical concretion. Velum well developed. There are 4 straight, narrow radial tubes and a slender, circular vessel. The small, swollen gonads are found upon the radial tubes about midway between margin of bell and manubrium. Serial sections of gonads have been studied by Brooks, 1888, Sigerfoos, 1893, and ourselves. The most careful study of their early stages has been made by Sigerfoos, while Brooks has presented good figures of their later conditions (see Brooks, 1888, Studies Johns Hopkins Univ. Biol. Lab., vol. 4, plate 15). It appears that the gonads may develop in one of two ways. They may develop into simple reproductive organs containing either male or female cells, or they may develop hydroid blastostyles which in turn give rise to free-swimming medusæ. According to Sigerfoos, if the latter is their destination, the following changes take place: The young reproductive organ consists of a layer of small ectodermal cells covering it externally, and a layer of larger entodermal cells lining it internally. As the organ grows the ectoderm becomes much thicker and many-layered by the multiplication of its cells. At the same time the cells of the entoderm enlarge and become vacuolated, but still remain in a single layer. Before the organ has matured, however, the outer layer of ectodermal cells becomes separated off from the remaining ectoderm by the appearance of a supporting lamella between them. At this stage, then, the organ consists of a single layer of small ectoderm cells covering it externally, and a single layer of large, vacuolated, entodermal cells lining it internally; between the two is the thick middle mass of cells of ectodermal origin. Evaginations of the entodermal lining then push out into the middle layer as finger-shaped processes. While this is taking place the entodermal cells of these processes undergo marked changes. They decrease very much in size and lose their vacuolated character. They then lose their connection with the entodermal lining of the gonad and become closed cylindrical tubes of entodermal cells lying within the middle mass of ectoderm-cells. The ectoderm of the bud is formed from the single layer of superficial ectoderm cells that overlies the gonad. Thus the bud is formed from both ectoderm and entoderm. When set free the young medusæ have 8 marginal tentacles, alternating with 8 lithocysts. The manubrium of the mature medusa is short and stout, and there are 4 recurved lips.

The entodermal lamella of the bell and the entoderm of the basal bulbs of the tentacles are of a delicate pink color. The entoderm of the gonads, of the manubrium, and of the budding medusæ is green. There are 4 interradial, longitudinal bands of dark-green entodermal pigment-spots upon stomach, and also a number of the same kind of spots upon gonads.

The medusa has been found by Brooks, and later by the present author among the Bahama Islands, and by Bigelow off the east coast of Florida. We have often found it at the Tortugas, Florida, in July. Brooks, 1888, claims to have found the hydroid stock of this species. The medusa was exceedingly abundant in Nassau Harbor, New Providence Island, Bahamas, late in July, 1903, and again common in the same place in April, 1907.

Phialidium gregarium Haeckel.

Oceania gregaria, Agassiz, L., 1862, Cont. Hist. Nat. U. S., vol. 4, p. 353.—Agassiz, A., 1865, North Amer. Acal., p. 74, fig. 103. *Phialidium gregarium*, Haeckel, 1879, Syst. der Medusen, p. 188.—Murbach and Shearer, 1903, Proc. Zool. Soc. London, vol. 2, p. 179, plate 20, figs. 1, 1*a*.

Bell nearly hemispherical, 12 mm. wide. 60 tentacles with large spherical bulbs. 1 or 2 lithocysts, each with 1 concretion, between each successive pair of tentacles. Stomach small with 4 very long, curved, fringed lips. 4 radial-canals with linear gonads on their outer (distal) halves. Color, white. Victoria Harbor, Puget Sound, British Columbia, in summer. Hydroid unknown.

Phialidium discoidum Bigelow.

Plate 33, figs. 9–11.

Oceania discoida, Mayer, 1900, Bull. Museum Comparative Zool. at Harvard College, vol. 37, p. 51, plate 20, figs. 53–55. *Phialidium discoida*, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 155, plates 6 and 38.

Bell quite flat, with conically sloping sides, and 4 mm. in diameter. 16 very short marginal tentacles with large basal bulbs; usually 3 lithocysts between each successive pair of tentacles. Velum well-developed. There are 4 straight radial-tubes, upon the greater part of the length of which the gonads are situated. In the female the eggs are very large and prominent. Manubrium urn-shaped, and there are 4 recurved lips. The stomach, gonads, and tentacle-bulbs are yellow or yellow-green. The entodermal supporting lamella of bell is often of a delicate shade of green. Found at Tortugas, Florida, in summer. Hydroid is unknown. This medusa is distinguished by its small size when mature and by its large gonads, which are developed over the greater part of the lengths of the radial-canals, not being restricted to their distal halves as in *P. hemisphærica* or *P. languida*.

Bigelow, 1909, has found this medusa in Acapulco Harbor, west coast of Mexico, and also in the West Indies. His largest specimens were further developed than mine, being 5.5 mm. wide. One of his medusæ, 3.5 mm. wide, had 46 tentacles. Usually there is only a single lithocyst between every pair of tentacles, each with 1 to 4 concretions.

Bigelow believes that *P. pacifica* Maas from Amboina is identical with *P. discoidum*.

Phialidium globosum.

Plate 34, fig. 4.

Oceania globosa, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 51, plate 9, figs. 19, 19*a*.

Bell globular in form, 14 mm. in diameter; cavity of bell shallow, so that the gelatinous substance is very thick. 32 large tentacles and 32 rudimentary ones. 64 lithocysts alternating with the tentacles. Each lithocyst contains 3 to 5 spherical concretions. There are 4 straight, narrow radial-canals. The 4 gonads are situated upon the distal parts of the canals. Manubrium very short, 4 prominent lips. Color of entoderm of stomach and tentacle-bulbs light-drab. Single specimen found at Tortugas, June 16, 1897.

Phialidium gelatinosum.

Plate 34, figs. 1, 1′.

Oceania gelatinosa, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 51, plate 10, figs. 20, 20*a*.

Bell 7 mm. high and 3.3 mm. in diameter. Gelatinous substance of upper part of bell very thick. 16 well-developed tentacles and 16 rudimentary ones that may develop later. 32 lithocysts alternating with the tentacles; each lithocyst contains 3 to 5 spherical concretions. Velum prominent. 4 radial-canals, in the upper or proximal part of which the gonads are developed. The manubrium is long and slender and there are 4 prominent lips. Color of ento-

derm, of stomach and tentacle-bulbs light-drab or opaque white. A specimen was found at the Tortugas, Florida, on June 14, 1897, and several others during the summers of 1899 and 1906.

Phialidium singularis.

Plate 35, figs. 9, 10.

Oceania singularis, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 7, plate 4, figs. 12, 13.—Nutting, 1901, Bull. U. S. Fish Commission for 1899, vol. 19, p. 380, fig. 96.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 50.

Bell 2 mm. in diameter, sides quite straight and sloping. Near apex of bell is a sharp constriction, above which is a lens-shaped, apical projection. 16 well-developed marginal tentacles with large, hollow, conical basal bulbs; lashes of tentacles short and covered with nematocyst-cells. Besides the 16 functional tentacles, there are 16 intermediate rudimentary or undeveloped ones. 32 lithocysts, each containing a single, highly refractive, spherical concretion. 4 straight radial-tubes. Manubrium quadrangular in cross-section, 4 simple lips. The 4 gonads are developed upon the 4 radial-canals near base of stomach.

The entoderm of the proximal part of each tentacle-bulb is turquoise-green; the distal part is brownish-red. The entoderm of the stomach and of the radial tubes in the neighborhood of the gonads is of a delicate turquoise tinge.

A single specimen of this medusa was found in Newport Harbor, Rhode Island, on August 22, 1896.

This medusa appears to be distinguished by the remarkable lens-shaped, gelatinous cap upon apex of bell, and by the fact that the gonads are almost adjacent to the sides of the manubrium. Unfortunately only a single specimen has been observed.

Phialidium pacificum Maas.

Oceania pacifica, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 167, plate 5, fig. 17.
(??) *Phialidium pacificum*, Maas, 1906, Revue Suisse de Zool., tome 14, p. 91, plate 2, fig. 7.

CHARACTERS OF THE FIJIAN SPECIMENS.

Bell moderately thick, but very flexible, hemispherical, 6 mm. in diameter. 16 thin, flexible tentacles of moderate length. Tentacle-bulbs large. There are 2 lithocysts between each successive pair of tentacles, and each lithocyst contains a single spherical concretion. Velum well-developed. There are 4 straight, narrow radial-canals, in middle regions of which the small, immature gonads are developed. Manubrium short, 8 simple lips. The entoderm of the tentacle-bulbs, of the stomach, and of radial-tubes in the region of the gonads is emerald green. Several specimens found at Suva and at Nukulau Islands, Fiji Islands, South Pacific, in December, 1897.

Maas found a single specimen of a medusa at Amboina, Malay Archipelago, which bears some resemblance to the Fijian specimens, but it has only 4 lips, while the medusæ from Fiji have 8. Moreover, the medusa from Amboina was smaller than those from Fiji, but had well-developed gonads, whereas the gonads of the Fijian medusæ were only beginning to appear.

The Malayan medusa is described by Maas as follows: Bell about 5 mm. in diameter, 32 equally spaced tentacles of a size similar each to each, and all somewhat less than half as long as bell-radius. There are 0 to 2 lithocysts between each successive pair of tentacles. The 4 large oval gonads occupy the middle thirds of the 4 radial-canals. This medusa may be identical with *P. discoidum*.

Phialidium iridescens Maas.

Phialidium iridescens, Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, Medusen, p. 12, taf. 1, fig. 6.

Bell 4 to 5 mm. wide, with about 32 tentacles, of which about 16 are well developed, with wide, conical bases, and 16 are small. No cirri. Stomach wide, with 4 small lips having complexly folded margins. 4 spindle-shaped gonads at middle points of the 4 radial-canals. Subumbrella iridescent. Antarctic Ocean, about 70° to 71° S. lat., 82° to 93° W. long.

Phialidium ambiguum.

Oceania ambigua, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 167, plate 6, figs. 18, 19.

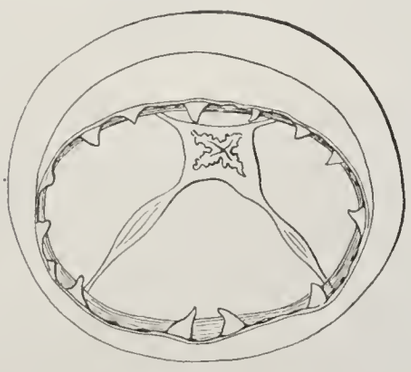
Bell pyriform, and 4 mm. in diameter. Gelatinous substance very thick. There are 16 short tentacles with large basal bulbs; 1 or 2 lithocysts between each successive pair of tentacles. Each lithocyst contains a single spherical concretion. Velum well-developed. 4 straight, moderately wide radial-canals. The immature gonads are situated upon these canals near the manubrium. Manubrium flask-shaped, 4 simple lips.

Entodermal axis of each tentacle brown; ectoderm of stomach, gonads, and tentacles, green.

Single specimen found at Suva, Fiji Islands, South Pacific, January 4, 1898. Distinguished by its very thick, pyriform bell.

Phialidium brunescens, described by Bigelow from the Maldive Islands, is closely related to this medusa, but is distinguished by its flat bell, thin walls, and the large size of the gonads in medusa smaller than *P. ambiguum* with small gonads. In both forms tentacle-bulbs are brown, but they appear to be much darker in *P. brunescens*.

147.



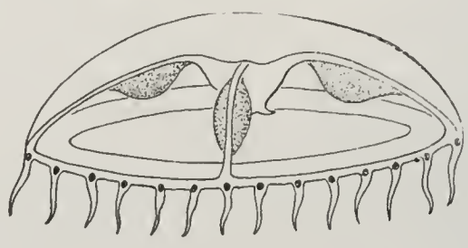


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Fig. 147.—*Phialidium iridescens*, after Maas, in Voyage S. Y. *Belgica*.

Fig. 148.—*Phialidium brunescens*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.

Phialidium brunescens.

Oceania brunescens, Bigelow, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 253, plate 1, fig. 2.

Bell flat, 2 mm. wide, 0.7 mm. high. About 30 short, thick tentacles with swollen bases. No tentacular knobs on the margin. 32 to 40 small lithocysts each with 1 or 2 concretions. Manubrium very short and broad, with 4 simple lips. The gonads are the most distinctive feature of this medusa, and are large, thick, and prominent, and occur on the proximal thirds of the 4 radial-canals. Bell colorless. Radial-canals and gonads greenish-yellow. Tentacles colorless, but with a prominent, brown pigment-spot at the base of each. Maldive Islands, Indian Ocean, in January. Distinguished by its swollen tentacle-bulbs, large hemispherical gonads, and flat bell with relatively thin walls. The nearly allied *P. ambiguum* of the Fiji Islands has a high, thick-walled, pyriform bell.

Phialidium simplex Browne.

Phialidium simplex, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 282; 1908, Trans. Roy. Soc. Edinburgh, vol. 46, p. 236.

Bell watch-glass-shaped, 22 mm. wide, 10 mm. high. 60 to 85 tentacles and a few rudimentary tentacle-bulbs. 60 to 85 or more lithocysts alternating with the tentacles. A single concretion in each lithocyst. Stomach short with 4 perradial lobes. Mouth with 4 large fimbriated lips. Gonads extend over outer halves of the radial-canals and almost reach the ring-canal. They are slightly folded. Common at Stanley Harbor, Falkland Islands, from November to February.

Genus PHIALUCIUM Maas, 1905.

Phialucium, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 32; 1906, Revue Suisse de Zool., tome 14, p. 92.—Bigelow, H. B., 1909, Mem. Comp. Zool. at Harvard College, vol. 37, p. 157.

Maas established the above as a subgenus of *Phialidium*. *Phialucium* resembles *Phialidium*, but has permanently rudimentary tentacle-bulbs upon the bell-margin. The stomach lacks a well-developed peduncle. The lithocysts may contain one or more concretions.

Plate 36.

Figs. 1 and 1″. *Phialucium carolinæ.* Figure 1′, part of bell-margin; figure 1″, side view of manubrium and radial-canal. Charleston Harbor, South Carolina, September, 1897.

Figs. 2 to 2‴. *Blackfordia manhattensis.* Figure 2′, part of the bell-margin, showing the projections from the tentacle-bulbs extending into the gelatinous substance of the bell; figure 2″, lithocyst; figure 2‴, portion of gonad. Off Sandy Hook, New York Harbor, October 16, 1904. See page 277.

Fig. 3. *Blackfordia virginica.* Aboral view looking down upon the manubrium of a male medusa. See page 277.

Fig 4. *Blackfordia virginica.* Part of the bell-margin showing the entodermal diverticula of the tentacle-bulbs which penetrate into the gelatinous substance of the bell.

Fig. 5. *Blackfordia virginica.* Gonad and manubrium of a mature female. Norfolk Harbor, Virginia, November 7, 1904.

Fig. 6. *Eucheilota duodecimalis.* Agassiz Laboratory, Newport, Rhode Island, August 8, 1892. See page 283.

Fig. 7. *Pseudoclytia pentata.* Oral view of the manubrium showing the 5 lips 72° apart. See page 278.

Drawn from life, by the author.

A. Meeds & Co.

The species are all closely related and are characterized by their large, urn-shaped, 4-sided stomachs and recurved lips with folded margins.

Maas established the genus with *P. virens* = *Oceania virens* Bigelow as a type. The first described species appears to be *P. mbengha* = *Mitrocoma mbengha* Agassiz and Mayer, 1899. The species are closely related one to another and had best be described in tabular form in order to present their differences most clearly.

Synopsis of the Species of Phialucium.*

	P. carolinæ = Oceania carolinæ Mayer, 1900.	P. mbengha Maas = Mitrocoma mbengha Agassiz and Mayer, 1899.	P. virens Maas, 1905 = Oceania virens Bigelow, 1904.
Shape and size of bell in mm.	Somewhat flatter than a hemisphere, 14 wide.	Somewhat flatter than a hemisphere, 9 wide.	Flatter than a hemisphere, 12 to 20 wide.
Number of well-developed tentacles.	16	16	16 to 25
Number of rudimentary tentacle-bulbs.	48	80±	40 to 80
Length of largest tentacle in terms of bell-radius (*r*).	*r*.	Less than *r*.	Less than *r*.
Number of marginal lithocysts.	62	32	32
Number of concretions in each lithocyst.	2	5 to 9	1 or 2
Shape and size of stomach.	Urn-shaped, with 4 recurved lips with folded lips. Longer than wide.	Urn-shaped, wider than long.	Urn-shaped. Slightly wider than long.
Position and character of gonads.	Linear, swollen, on outer halves of the 4 radial-canals.	Linear, swollen, on outer halves of the 4 radial-canals.	Linear, swollen, on outer halves of the 4 radial-canals.
Color.	Entoderm of stomach, tentacle-bulbs, and gonads, bright yellow-green.	Entoderm of stomach, gonads, and tentacle-bulbs yellow. Radial-canals grass-green.	Entoderm of gonads, tentacles, and stomach light yellowish-green.
Where found.	Charleston Harbor, South Carolina, and Florida, in summer.	Suva Harbor, Fiji Islands, Pacific, in January.	Maldive Islands, Indian Ocean, Malay Archipelago.

*For *Phialucium comata* see text.

Phialucium carolinæ Maas.

Plate 36, figs. 1–1″.

Oceania carolinæ, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 7, plates 3, 4, figs. 9–11.
Phialucium carolinæ, Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 32.

Bell not quite a hemisphere, 14 mm. in diameter. Cavity of bell shallow, so that the gelatinous substance is quite thick. 16 well-developed, marginal tentacles with large, hollow basal bulbs. These are only about half as long at the bell-diameter, but as they are usually carried coiled in a close helix they appear much shorter. Besides the well-developed tentacles, there are 48 small, rudimentary tentacle-bulbs that probably never develop into tentacles. 64 lithocysts, 4 between each adjacent pair of large tentacles. Each lithocyst contains 2 spherical concretions. Velum well developed. 4 narrow, straight radial-canals. Mature manubrium flask-shaped, 4 simple curved lips. The gonads are developed upon the radial tubes beyond their middle points. Ova in female very conspicuous. Entoderm of tentacle-bulbs, manubrium, and radial tubes in region of the gonads bright yellow-green.

This species was extremely abundant in Charleston Harbor in the early part of September, 1897, and in June, 1898. It is found occasionally at Tortugas, Florida.

Phialucium virens Maas.

Oceania virens, Bigelow, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 252, plate 1, figs. 3, 4.
Phialucium virens, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 32, taf. 4, fign. 36, 37; 1906, Revue Suisse de Zool., tome 14, p. 93.

Bell flat, shield-shaped, lenticular, with thin but firm gelatinous substance; 12 to 20 mm. wide, 4 to 7 mm. high; 16 to 20 short tentacles, irregularly arranged, tapering, and about half as long as the bell is high. Besides the tentacles there are 30 to 80 rudimentary tentacular knobs upon the bell-margin, irregularly scattered between the tentacles. 32 lithocysts, each with one or two spherical concretions; the lithocysts are somewhat irregularly scattered, there being usually 2 or 3 between each pair of tentacles. Manubrium short, flask-shaped, very distensible, 4 pointed lips. 4 large gonads on distal halves of the 4 radial-canals.

Bell colorless. Gonads, manubrium, and tentacles light yellowish-green.

Maldive Islands, Indian Ocean; December and January. Malay Archipelago. Quite rare.

This form is probably identical with *P. mbengha* of the Fiji Islands, but its lithocysts appear to contain only 1 or 2 concretions instead of 5 to 9 as in *P. mbengha*.

Phialucium comata Bigelow.

Phialucium comata, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 39, p. 158, plates 5, 6, and 37.

Bell somewhat higher than a hemisphere, 6 to 12 mm. in diameter. Gelatinous substance thick, bell-cavity deep. In Pacific medusæ there are about 17 tentacles and 23 rudimentary knobs on the bell-margin, but in the West Indian variety, when 12 mm. wide, there are 19 tentacles and 62 knobs, and at all stages there are more knobs in the West Indian medusæ. The tentacles are short, with swollen basal bulbs flanked by 1 to 3 pairs of lateral cirri. Cirri also flank the larger knobs. There are 7 to 14 large closed lithocysts. Number of concretions (?) Manubrium short, flask-shaped with a low peduncle and 4 slightly crenulated lips. Gonads linear from the middle third to near the outer ends of the 4 radial-canals. Gonads greenish, other parts colorless. Found in Acapulco Harbor, Pacific coast of Mexico, and at Guadeloupe, West Indies. Distinguished by its lateral cirri and few but large lithocysts. It falls within Torrey's new genus, *Phialopsis*, and may more properly be called *Phialopsis comata*. (See appendix.)

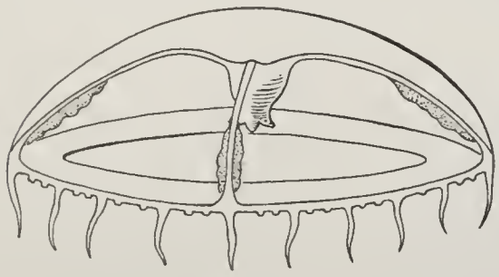


Fig. 149.—*Phialucium virens*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.

Phialucium mbengha Maas.

Mitrocoma mbengha, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 168, plate 8, figs. 24, 25.
Phialucium mbengha, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 32.

For description see synoptic table of *Phialucium*.

Genus BLACKFORDIA, gen. nov.

This genus is named in honor of my friend, the late Eugene G. Blackford, who, as Fish Commissioner of the State of New York, was a pioneer in the solution of important problems in the commercial culture and propagation of food-fishes; and whose active interest in behalf of the institution of the New York Aquarium entitles him to be remembered as a founder of that beneficent educational establishment.

GENERIC CHARACTERS.

Eucopidæ with numerous closed, vesicular lithocysts upon the bell-margin between the tentacles. The entodermal cores of some or all of the tentacles extend inward from the bell-margin into the gelatinous substance of the bell. The manubrium lacks a peduncle. No marginal cirri. No permanently rudimentary tentacles. Hydroid unknown.

This genus is distinguished from *Obelia* by the numerous (more than 8) lithocysts upon the bell-margin. In general appearance the medusæ remind one of A. Agassiz's figure of

Plate 37.

Fig. 1. *Eucheilota duodecimalis.* Immature female, with only 4 lithocysts. Agassiz Laboratory, Newport, Rhode Island, September 19, 1896. See page 283.

Fig. 2. *Eucheilota duodecimalis.* Mature female, with 12 lithocysts. Agassiz Laboratory, Newport, Rhode Island, September 7, 1895.

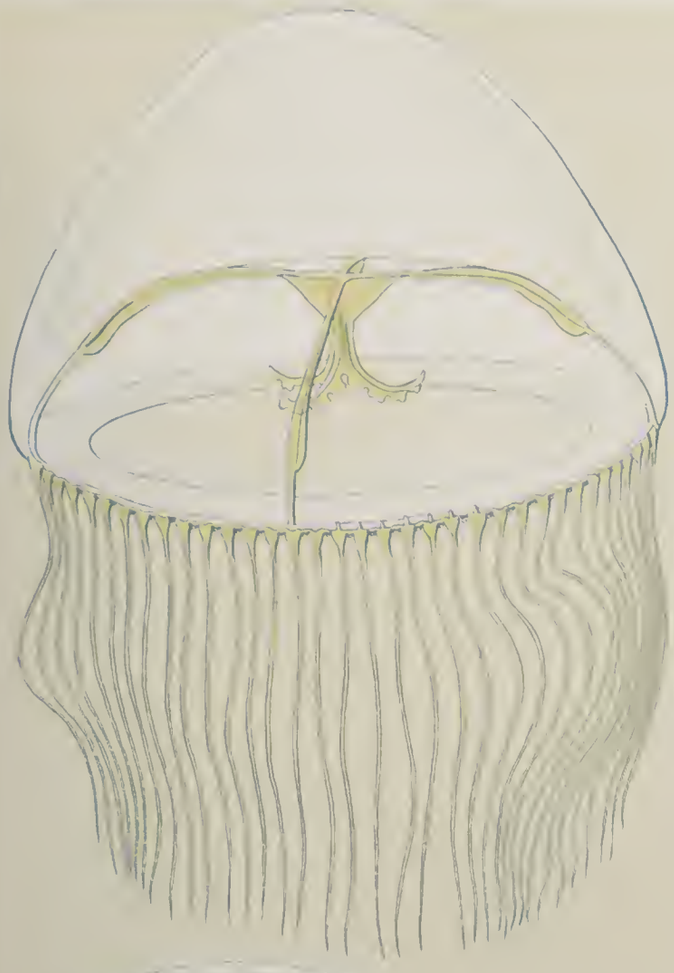
Figs. 3 to 3″. *Eucheilota paradoxica.* Producing medusa-buds upon its gonads. Figure 3′, medusa-bud about to be set free from the gonad of the parent medusa; figure 3″, section of the gonad and budding medusa. Tortugas, Florida; and Nassau, Bahamas, June 1899, 1903. See page 285.

Fig. 4. *Eucheilota bermudensis*, young medusa. Tortugas, Florida. June 17, 1899. See page 282.

Fig. 5. *Eucheilota ventricularis*, young medusa. Tortugas, Florida. June, 1899. See page 282.

Fig. 6. *Blackfordia virginica*, mature medusa. Hampton Roads, Virginia. October 31, 1904. For details see figures 3 to 5, plate 36.

Drawn from life, by the author.



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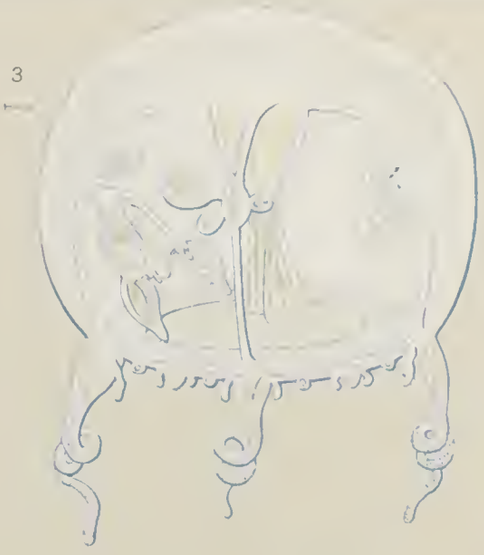

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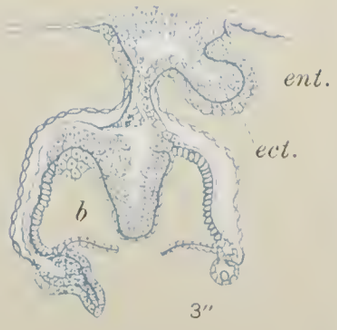

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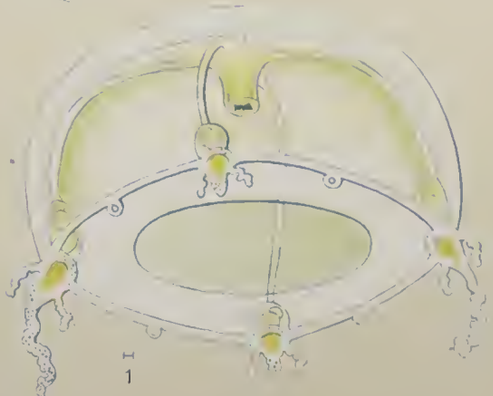

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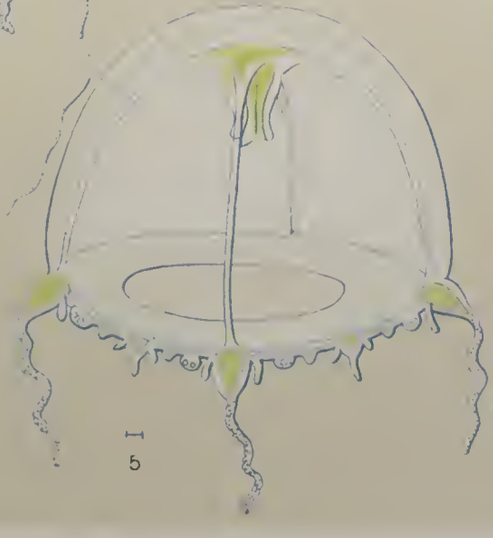

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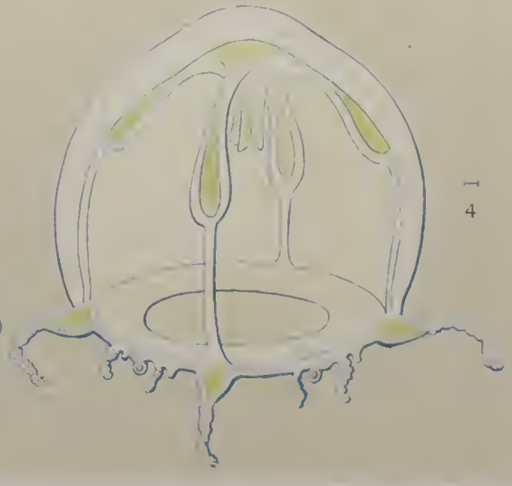

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A. Hagen & Co.

Halopsis (*Mitrocoma*) *cruciata*, 1865 (North Amer. Acal., p. 102, figs. 151, 152). Dr. Agassiz, however, describes cirri upon the bell-margin between the tentacles in *H. cruciata*, and states that there are but 12 marginal sense-organs, 3 in each quadrant. In *Blackfordia* there are no cirri and the marginal sense-organs are very numerous. *Blackfordia* is distinguished from *Phialucium* and *Phialopsis* by the absence of permanently rudimentary tentacles or cirri.

The medusæ of *Blackfordia* are also quite similar to *Tiaropsis* in the appearance of the manubrium and general shape of the bell, but in *Tiaropsis* there are but 8 marginal sense-organs and the entodermal cores of the tentacles do not project inward into the gelatinous substance of the bell, as in *Blackfordia*.

The type species is *Blackfordia manhattensis*, found off the coast of New Jersey, United States.

Blackfordia manhattensis, sp. nov.

Plate 36, figs. 2–2‴.

Bell 10 mm. in diameter, higher than a hemisphere, with relatively flat, sloping sides and bluntly rounded apex. Bell-cavity about half as deep as bell-height. 70 to 80 slender tentacles with short, blunt, basal bulbs. The tentacle-bulbs give rise each to a finger-shaped entodermal diverticulum, which extends upward into the gelatinous substance of the bell. There are usually 2, and sometimes 3, lithocysts between each successive pair of tentacles; the lithocysts contain 2 to 5 spherical concretions, the large lithocysts having almost invariably 5 concretions. There is *no* black pigment at the base of the lithocysts, as in *Blackfordia virginica*. There are 4 straight, narrow radial-canals and a slender circular vessel. Velum well developed. The manubrium is quadratic in cross-section and about half as long as depth of bell-cavity; it is provided with 4 very long, slender, frilled lips. The gonads are found on the middle parts of the radial-canals and are irregularly flexed, sinusoidally, from one side to the other of the canal.

Entoderm of manubrium sage-green; that of tentacles and gonads lighter in color, being almost milky.

This medusa is common off Sandy Hook and other parts of the coast of New Jersey in October.

Blackfordia virginica sp. nov.

Plate 36, figs. 3–5; plate 37, fig. 6.

Mature medusa (plate 37, fig. 6).—Bell 14 mm. wide, somewhat higher than a hemisphere, with relatively straight, sloping sides and rounded apex. There are about 80 long, slender tentacles, capable of much contraction; tentacle-bulbs short and swollen. A finger-shaped entodermal projection extends upward from some of the tentacle-bulbs into the gelatinous substance of the bell. In some medusæ only about one-quarter of the tentacles display these diverticula, in others it is exhibited by fully three-quarters of the tentacles. There are usually 1, rarely 2, lithocysts between each successive pair of tentacles. Each lithocyst contains typically 2, but occasionally 3 or more spherical concretions. The entoderm of the bell-rim at the bases of the lithocysts contains dense-black pigment-granules. Bell-cavity about half as deep as bell-height. Velum large. 4 straight, slender radial-canals. Manubrium quadratic in cross-section, flask-shaped, with recurved and prominently fluted lips; it extends about half the distance from inner apex of bell-cavity to velar opening. Gonads linear, extending from radial corners of stomach over somewhat more than half the length of the radial-canals. The eggs of female protrude from the surface of the ectoderm and are cast off one by one (plate 36, fig. 5).

The entoderm of the tentacle-bulbs and gonads is dull milky-yellow, while that of the stomach is often of a delicate green.

When the medusa is 0.8 mm. in diameter the bell is higher than a hemisphere, with thin flexible walls. There are 8 tentacles and 8 lithocysts, each containing 1 or 2 spherical concretions, one concretion being usually larger than the other. Lips only slightly recurved and not fluted. There are as yet no gonads and no black pigment in the entoderm of the bell-rim. This black pigment begins to develop when the medusa has 16 tentacles and the bell is hemispherical and 1.7 mm. in diameter.

This medusa was abundant in Hampton Roads and Norfolk Harbor, Virginia, in October and November, 1904. It is at once distinguished from *Blackfordia manhattensis* by the dense-black entodermal pigment-granules adjacent to the lithocysts.

Genus PSEUDOCLYTIA Mayer, 1900.

Pseudoclytia, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 53.—Browne, 1904, Fauna and Geog. Maldive, etc., vol. 2, plate 3, p. 730.—Maas, 1906, Revue Suisse de Zool., tome 14, p. 94.

This genus was founded by Mayer, 1900, for *Pseudoclytia pentata* of the Tortugas, Florida.

GENERIC CHARACTERS.

Eucopidæ with 5 simple radial-canals, 72° apart. The manubrium lacks a peduncle and is provided with 5 simple lips. 5 gonads upon the 5 radial-canals. Tentacles and lithocysts numerous. No cirri.

Browne, 1904, described a medusa from the Maldive Islands, Indian Ocean, which may belong to this genus, but it appears to be unsymmetrical, whereas the Tortugas species is normally pentamerous and radially symmetrical.

Pseudoclytia is probably derived by mutation from some 4-rayed Clytia-like ancestor.

Pseudoclytia pentata Mayer.

Plate 35, figs. 4 to 6; plate 36, fig. 7.

Pseudoclytia pentata, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 53, plate 12, figs. 24–26; plate 15, figs. 35, 35*a*; plate 39, figs. 131, 132; 1901, Sci. Bulletin, Museum Brooklyn Institute Arts and Sci., vol. 1, p. 3, plates 1–2, figs. 1–67 (variations of 1,000 specimens).—Davenport, 1901, Biometrika, Cambridge, vol. 1, p. 255 (variations).—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, part 3, p. 730.

Adult medusa (plate 35, fig. 4).—Bell flatter than a hemisphere and 8 to 13 mm. in diameter. 20 simple tentacles with well-developed basal bulbs; each tentacle a little less than half as long as bell-height. Neither lateral nor marginal cirri. 20 lithocysts alternate in position with the 20 tentacles; each lithocyst contains a single spherical concretion. Velum well developed. There are 5 straight, narrow radial-canals, 72° apart. The 5 short, oval gonads are situated upon the radial-canals at points midway between the manubrium and bell-margin. In the female the ova are large and prominent, and when immature are seen to have a well-defined nucleus and nucleolus. Manubrium flask-shaped, 5 simple recurved lips.

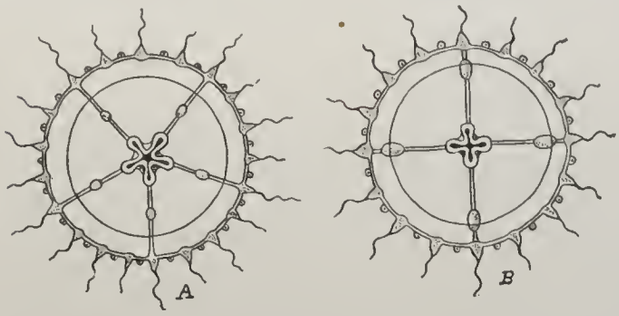


Fig. 150.—*A. Pseudoclytia pentata. B. Clytia folleata.*

The entoderm of the stomach, gonads, and tentacle-bulbs is usually slightly milky in color with a few scattered cinnamon-colored granules. Occasionally an individual is met with in which these cinnamon-colored granules are developed to such an extent that the medusa is brick-red (plate 35, fig. 6). In most individuals, however, the colored granules are so faint as to be almost imperceptible. In some specimens there is a more or less decided green spot in the entoderm of each tentacle-bulb.

This medusa was exceedingly abundant at Tortugas, Florida, from June to August, 1897 to 1904. In 1905 it was relatively rare, and only 3 specimens were seen throughout the summers of 1906 and 1907 although extensive search was made daily with the tow-net, and not a single specimen could be found in 1908. At times during July, 1898, these medusæ were so abundant upon the surface that one could not dip up a bucketful of water without capturing several specimens. In 1909 it again appeared in fair numbers.

This is the only *pentamerous* Hydromedusa known, and it has apparently arisen as a self-perpetuating sport, or mutation, from some species of *Clytia* or *Phialidium*. Indeed the medusa bears a close superficial resemblance to *Clytia folleata* McCrady, which is also abun-

dant at Tortugas. It may be distinguished, however, by its color and the position of its gonads upon the radial-canals, so that abnormal 4-rayed specimens of *P. pentata* can be distinguished from the normal *Clytia folleata*.

Believing that *P. pentata* may be a successful mutation from some *Clytia*, in 1899 I carried out a study of the variations of 1,000 specimens. The following is a summary of the results: Among 1,000 specimens of *P. pentata*, 703 were normal and had 5 radial-canals and 5 lips, 72° apart, while 297 were abnormal. Of the abnormal medusæ 151, or fully half, were radially symmetrical. Medusæ which are not radially symmetrical are very apt to be bilaterally symmetrical. Normal 5-rayed medusæ are more apt to be fertile and produce more ova than do abnormal medusæ, and thus the abnormal forms are produced at a disadvantage. The commonest aberration is to display 4 radial-canals or 4 lips, or both, thus apparently reverting to the ancestral type. The radial-canals ranged from 2 to 8, and the lips from 1 to 7. The correlation in number between the radial-canals and the lips becomes less and less perfect as we depart from the normal condition of 5 canals and 5 lips. 4 monstrous medusæ with 2 manubria, recalling the condition normal in *Gastroblasta*, were observed. Upon its reappearance in 1909 the medusæ were still highly variable.

Pseudoclytia gardineri Browne.

Pseudoclytia gardineri, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 731, plate 55, figs. 1–3.

Bell 5 mm. wide; gelatinous substance quite thin. About 13 to 14 tentacles about as long as bell-radius and with globular basal bulbs. Rudimentary tentacle-bulbs somewhat more numerous than tentacles and irregularly spaced, showing a tendency to cluster in one quadrant where there are 6 bulbs, 3 on each side of a tentacle. There are 2 or 3 small lithocysts between each successive pair of tentacles; about 32 lithocysts in all. 5 radial-canals somewhat irregularly spaced; 4 of them are about 90° apart, and the fifth bisects the space between two of the canals. Stomach small, without peduncle, and with 4 or 5 short lips. A small gonad at the middle of each radial-canal. Maldive Islands, Indian Ocean; Milandumadulu Atoll. Only 2 specimens found. It is possibly an abnormal *Phialidium*.

Genus GASTROBLASTA Keller, 1883.

Gastroblasta, Keller, 1883, Zeit. für wissen. Zool., Bd. 39, p. 622.—Lang, 1886, Jena. Zeit. für Naturwissen., Bd. 19, p. 735.
Multioralis, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 54.

The type species is *Gastroblasta timida* Keller, from the Red Sea. A second species was found by Lang at Naples, Italy, and another is found at Tortugas, Florida.

GENERIC CHARACTERS.

Eucopidæ with 2 or more radial-canals and more than 1 manubrium. The tentacles have hollow basal bulbs and the lithocysts are simple, closed sacs each containing a single concretion. These lithocysts are numerous and are upon the bell-margin alternating with the tentacles. The gonads are upon the radial-canals. The manubria have typically 4 lips. No peduncle. New radial-canals arise as centripetal in-growths from the ring-canal.

Gastroblasta timida Keller.

Gastroblasta timida, Keller, 1883, Zeit. für wissen. Zool., Bd. 38, p. 622, taf. 35, 5 fign.; *Ibid.*, Sitzungs. Ges. Naturw. Jena., p. 8.

In large specimens of the medusa the bell is 3 to 4 mm. wide and 1 to 1.5 mm. high. There are 1 to 4 manubria and 4 to 17 radial-canals with 17 blindly ending centripetal vessels. The most complex example (fig. 151) was 4 mm. wide, the margin being circular in outline, not elliptical as in *G. raffælei* of Naples, where there were 4 manubria near the center of the subumbrella. The largest (oldest) mouth was at the center of the subumbrella and had 5 lips, and the 3 other manubria were smaller, and 2 of them had each 3 lips, while the smallest manubrium was rudimentary and its mouth was undeveloped. The stomachs were all connected one with another by vessels and 17 canals radiated out from them to the ring-canal at the bell-margin. These canals fused irregularly one with another in some instances, but in other cases they extended in a straight line from the stomach to the circular-canal. There was a well-

developed, spindle-shaped gonad upon each of the 17 radial-canals near the middle of its length. 17 short, straight, blindly ending, centripetal canals alternated with the 17 complete radial-canals. In this specimen the centripetal canals lacked gonads, but in other individuals gonads were observed upon the centripetal canals even before they had fused with the stomach. In the specimen under consideration there were (17 × 4) 68 tentacles alternating with 68 closed lithocysts each containing a single oval concretion. The velum is wide and muscular. The simplest medusa observed had a hemispherical bell about 1 mm. wide, 8 tentacles (4 radial and 4 interradial); central stomach with 4 lips, no gonads, no centripetal canals, and no lithocysts.

This medusa occurred in large numbers for a few days only early in March, 1882, in the Harbor of Suakin, Red Sea.

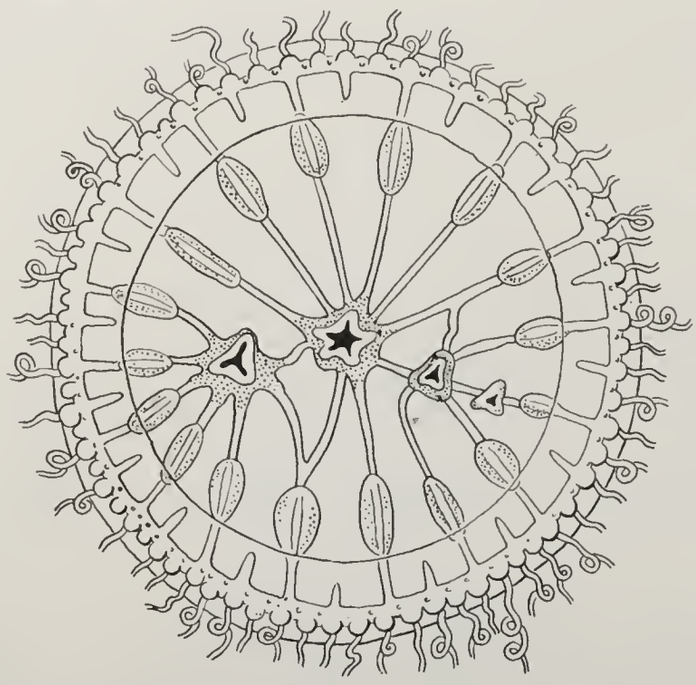


FIG. 151.—*Gastroblasta timida*, after Keller, in Zeit. für wissen. Zool.

Gastroblasta raffælei Lang.

Phialidium variabile, DAVIDOFF, 1881, Zool. Anzeiger, Bd. 4, p. 620, 1 fig.
Gastroblasta raffælei, LANG, 1886, Jena. Zeit. für Naturwissen., Bd. 19, p. 735, taf. 20, 21, 32 fign.
(?) *Eucope polygastrica*, METSCHNIKOFF, E., 1870, Verhandl. kaiserlichen Gesell. Freunde Naturwissen. Moskau, tome 8, p. 346, taf. 4, figs. 2, 4; Arbeit. Zool. Inst. Wien, 1886, p. 260.

This remarkable medusa was found in great numbers in August and September, 1885, at Naples, Italy. It is characterized by having usually more than one stomach, a variable number of radial-canals, a well-developed ring-canal, and a number of hollow, bulbed tentacles of various ages. Upon the bell-margin, between the tentacles, are simple, closed lithocysts, each with a single concretion. These concretions are of various ages.

The simplest medusæ had 8 well-developed tentacles and 10 small, as yet undeveloped, tentacle-bulbs. There were also 10 lithocysts upon the bell-margin between the tentacles. Near the center of the subumbrella were 4 manubria, 1 large, 2 small, and 1 very small (as yet undeveloped). The functional manubria always have 4 lips; the 2 oldest are joined by a chymiferous canal, and this forks so that 4 main radial-canals reach the circular vessel. The 4 oldest tentacles are at the ends of these 4 main radial-canals. The disk is never exactly circular, but more or less elliptical, the long axis of the ellipse being in the line of the vessel which connects the 2 oldest manubria. Velum well developed, disk flat and thin.

This medusa often reproduces itself by fission. The plane of division is at right angles to the long axis of the ellipse and passes between the oldest and next oldest manubrium. When about to divide, the oldest lithocyst divides into two and the cleft proceeds inward at this

point until the medusa is completely cut into halves, the one being a reflection of the other. Each then develops new radial-canals, manubria, and tentacles, the new radial-canals budding from the ring-canal and growing inward. When the original form has been restored, a new fission may take place. This is not a constant process, however, but is subject to much variability, for new radial-canals may grow inward from the ring-canal in the regions of the older tentacles, and these new canals may fuse with the old canal-system and develop manubria.

Thus the largest medusa seen had a diameter in its long axis of 4 mm. and in its short axis of 2.7 mm. There were 26 well-developed and 17 rudimentary tentacles, 34 lithocysts scattered between the tentacles, 20 radial and centripetal canals, 9 complete and 7 rudimentary (undeveloped) stomachs. The stomachs are urn-shaped with thick walls; the mouth-tube is elongate, 4-sided, and with 4 well-developed lips. Gonads sometimes develop upon one or more of the radial-canals, the mature sperm or ova being ectodermal. These gonads occur near the middle of the canals upon which they develop.

The medusa may be regarded as primitively 4-rayed, but this condition is masked by its peculiar processes of asexual reproduction and growth. It is described in detail by Lang.

Gastroblasta ovalis.

Plate 35, figs. 7 and 8.

Multioralis ovalis, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 54, plate 39, figs. 129, 130.

Adult medusa.—Bell quite flat, elliptical in outline, the major axis being 4 mm. and the minor 2.4 mm. The gelatinous substance is not very thick and is quite flexible. 20 to 25 short, simple, coiled tentacles with well-developed basal bulbs. These tentacles are only about half as long as the minor axis of the bell. Neither lateral nor marginal cirri. Lithocysts slightly more numerous than the tentacles, usually 1, but occasionally 2, being found between each successive pair of tentacles. In each lithocyst is a single, spherical concretion. Velum simple and quite broad. There is a slender circular vessel, and a single, straight, chymiferous canal extends along the major axis of the bell. In the oldest medusæ observed there were 4 manubria, 2 equally developed large manubria on either side of the center of subumbrella, upon the chymiferous canal; and 2 small manubria upon the same canal centrifugally away from the larger manubria. There was thus no manubrium at the center of the subumbrella. There were 2 small gonads upon the chymiferous canal immediately centrifugal from the small manubria.

The entoderm of the manubria and of the basal bulbs of the tentacles is an opaque, glistening white. The supporting lamella of the bell is of a delicate green.

Young medusa.—In the youngest medusa observed, there were but 2 manubria upon the chymiferous canal on either side of center of disk. The major axis of the bell was 2.5 mm. and there was no trace of gonads. About a dozen specimens of this medusa were captured at the Tortugas, Florida, from June 30 to July 2, 1899, and none have been seen since that time. It seems possible that the bell of the large medusa may divide by transverse fission, for one individual was found in which there was a decided notch in the bell-margin extending inward in the plane passing through the center of the subumbrella perpendicular to the main chymiferous tube. This notch appeared, however, upon only one side of the bell and may have been due to accident. Apparently the main chymiferous canal is equivalent morphologically to 2 diametrically opposed radial-canals.

Genus EUCHEILOTA McCrady, 1857.

Eucheilota, McCrady, 1857, Gymn. Charleston Harbor, p. 85.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 353.—Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 56.
Euchilota, Agassiz, A., 1865, North Amer. Acal., pp. 74–76.—Browne, 1896, Proc. Zool. Soc. London, pp. 481, 484.
Euchilota=Phialium, Haeckel, 1879, Syst. der Medusen, pp. 179, 180.
Oceanopsis, Fewkes, 1883, Bull. Mus. Comp. Zool. at Harvard College, vol. 11, p. 86.
Dipleuron, Brooks, 1882, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 139.
Phialium, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 153.

This genus was founded by McCrady, 1857, for *Eucheilota ventricularis* of the Atlantic coast of the United States.

GENERIC CHARACTERS.

Eucopidæ with 4 or more small, closed, vesicular lithocysts, each containing 1 or more concretions. There are lateral or marginal cirri or both. The gonads are developed upon the 4 radial-canals. There is no peduncle. The hydroid is *Campanulina*(?)

The species of this genus vary greatly in the number of lithocysts and tentacles. In fact, were we to attempt to classify them according to the number of these structures it would be necessary to erect a separate genus for each one of the known species, as has practically been done by Haeckel, 1879. I believe, therefore, that generic distinctions based upon the number of lithocysts and tentacles are of no value in the classification of these species. Among the known species of *Eucheilota* the lithocysts vary from 4 to 32 and the tentacles from 4 to 30.

The genus *Eucheilota*, as we define it, consists of Eucopidæ with small, closed lithocysts, while in *Mitrocoma* the lithocysts are open sacs containing usually a large number of concretions. Both of these genera possess marginal and lateral cirri and are very closely related.

Eucheilota paradoxica is remarkable in that it develops medusa-buds upon its gonads. These budding medusæ are developed from both ectoderm and entoderm of the parent gonad, both layers taking their proportionate share in the formation of the daughter medusa as in *Sarsia* or in hydroids generally. Such budding of medusæ is common in Anthomedusæ, but exceedingly rare in Leptomedusæ.

Eucheilota ventricularis McCrady.

Plate 37, fig. 5; plate 38, figs. 1 to 1″.

Eucheilota ventricularis, McCrady, 1858, Gymn. Charleston Harbor, p. 85, plate 11, figs. 1, 2; plate 12, figs. 1–3.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 353.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 94, figs. 16, 17.—Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 159, plate 5, figs. 7–10.—Brooks, 1882, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 139.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 46, plate 4, fig. 4.—Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 55, plate 38, fig. 128.
Euchilota ventricularis, Agassiz, A., 1865, North American Acalephæ, p. 74, figs. 104, 105.—Haeckel, 1879, Syst. der Medusen, p. 179.

Bell hemispherical, 10 mm. in diameter. 16 well-developed tentacles with long, tapering, hollow, basal bulbs; each tentacle-bulb is flanked by a pair of short cirri. Besides the large tentacles there are 16 small projections on the bell-margin, each flanked by a pair of cirri, and about 24 very minute projections not flanked by cirri. 8 lithocysts, 2 in each quadrant and each containing about 8 spherical concretions arranged in a half circle. Velum well developed. There are 4 straight, narrow radial-canals and a slender, circular vessel. Manubrium is short and quadratic, provided with 4 prominent recurved lips. The gonads are linear and are found in the middle regions of the radial-canals, each gonad being about one-third as long as the canal upon which it is situated. In the female the eggs project from the surface of the ectoderm of the gonads.

The entoderm of the stomach, gonads, and tentacle-bulbs is a decided green.

During the summer and autumn this medusa has been found in Hampton Roads, Virginia; at Beaufort, North Carolina; Charleston, South Carolina; and Tortugas, Florida. It is rare on the southern coast of New England and is probably only occasionally carried there by the northerly drift from the Gulf Stream.

In the young medusa the bell is higher than a hemisphere. There are 4 radially situated tentacles with lateral cirri. The gonads do not develop until the medusa has attained a considerable size.

Eucheilota bermudensis Mayer.

Plate 37, fig. 4; plate 38, figs. 2, 3.

Oceanopsis bermudensis, Fewkes, 1883, Bull. Museum Comp. Zool. at Harvard College, vol. 11, p. 86, plate 1, figs. 8–10.
Eucheilota bermudensis, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 56.

Adult medusa (plate 38, fig. 3).—Bell not quite hemispherical, the sides being relatively straight and sloping and top quite flat. It is about 6 mm. in diameter. 8 tentacles, 4 radial and 4 interradial; tentacles only about a third as long as bell-diameter, and thickly covered with nematocysts; their basal bulbs large, each flanked by a pair of short, coiled, nematocyst-

Plate 38.

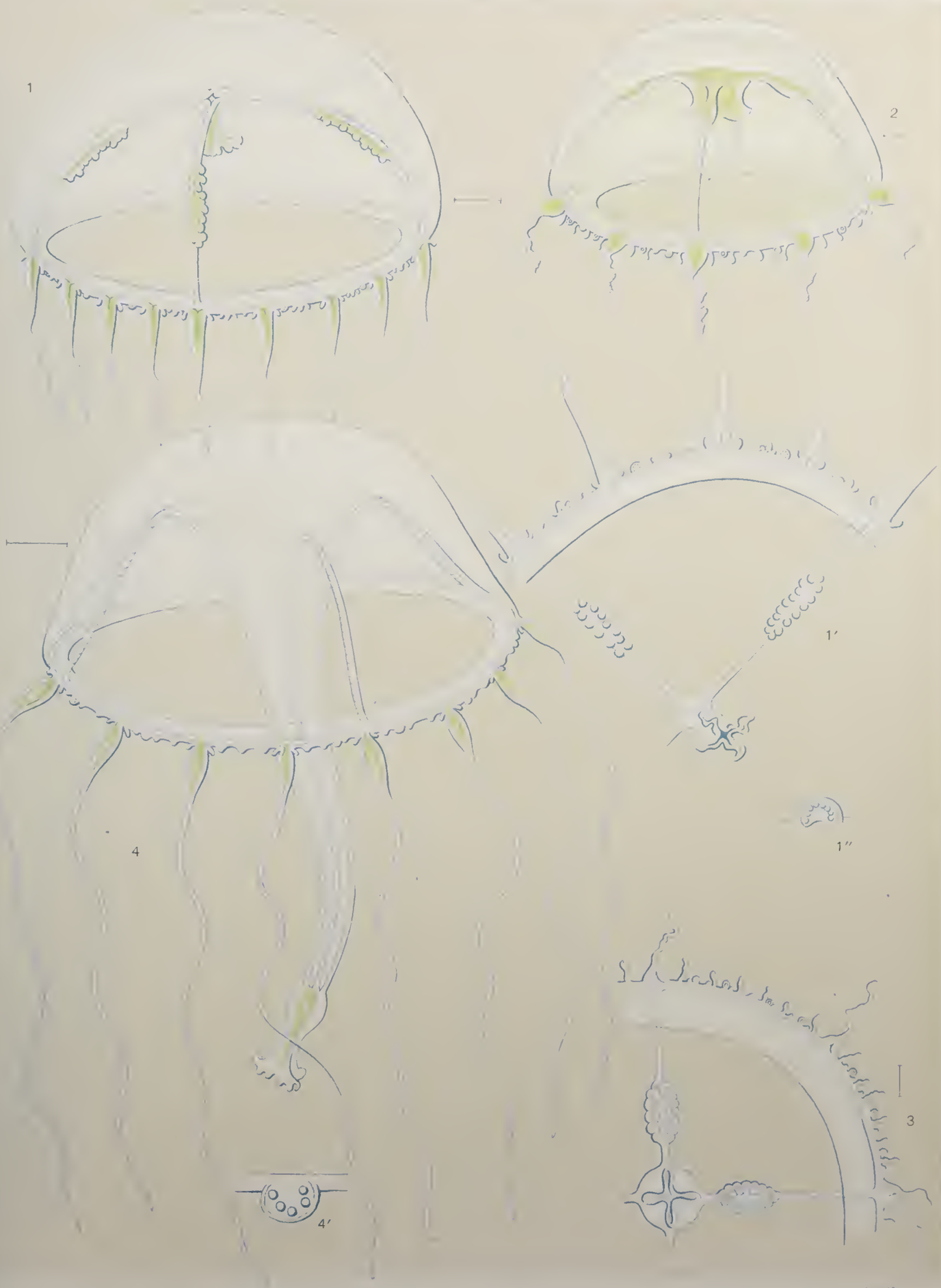
Figs. 1 to 1″. *Eucheilota ventricularis*, mature female. Figure 1′, oral view of the same medusa; figure 1″, one of the marginal lithocysts. Hampton Roads, Virginia, November 3, 1904.

Fig. 2. *Eucheilota bermudensis*, immature medusa. Tortugas, Florida, June 18, 1899.

Fig. 3. *Eucheilota bermudensis*, mature female. Tortugas, Florida, June 19, 1899.

Figs. 4 and 4′. *Eirene variabilis*. Figure 4′, lithocyst of the same medusa. Charleston Harbor, South Carolina, September 9, 1897.

Drawn from life, by the author.



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bearing cirri. In addition to these there are normally about 8 other cirri in each quadrant, and scattered between them are 8 lithocysts. Thus the medusa has 32 lithocysts and 48 cirri. Each lithocyst is of small size and contains a single spherical concretion. The velum is well developed. There are 4 straight, narrow radial-canals and a simple circular vessel. The manubrium is short but wide, and there are 4 cruciform, slightly recurved lips. There is no peduncle. The 4 gonads are found upon the 4 radial-canals near the manubrium. These are visible in young medusæ about 1.5 mm. in diameter; and in the adult they become quite large and swollen, the ova being distinctly seen lying along the side of the canal. The entoderm of stomach, gonads, and tentacle-bulbs is grass-green, and the supporting lamella of the bell is tinged with the same color.

This medusa was quite common at the Tortugas, Florida, from June 17 to 25, 1899. Fewkes found it at Bermuda.

Young medusa.—The youngest medusa seen by me was about 2 mm. in height and 1.5 mm. in diameter. It was nearly in the condition described by Fewkes, 1883. There were 4 simple, radially situated tentacles and 4 interradial tentacle-bulbs. The interradial tentacle-bulbs were flanked by lateral cirri, while the radial tentacle-bulbs lacked these appendages. There were 4 lithocysts, one upon the side of each of the interradial tentacle-bulbs. Each lithocyst contained a single spherical concretion. The gonads were already quite large, and lay along the 4 radial-canals near the sides of the manubrium. The manubrium is short with 4 simple lips.

Eucheilota duodecimalis A. Agassiz.

Plate 36, fig. 6; plate 37, figs. 1 and 2.

Eucheilota duodecimalis, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 353.—Agassiz, A., 1865, North American Acalephæ, p. 75, figs. 106–107*a*.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 378, fig. 95, A, B.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 46, plate 4, fig. 3.

Phialium duodecimale, Haeckel, 1879, Syst. der Medusen, p. 180.—Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 297, plate 1, figs. 17–21.

Phialium dodecasema, Haeckel, 1879, Syst. der Medusen, p. 181.

Phialium duodecimalis, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 154, plates 6 and 38.

Adult medusa.—Bell slightly higher than a hemisphere, about 2.5 mm. in diameter; bell-walls quite thin, no thicker at apex than near the margin. There are 4 long, slender, radially situated tentacles with large basal bulbs and lateral cirri; lateral cirri short and covered with nematocyst-cells. Each tentacle-bulb is flanked by 2 cirri. There are 12 lithocysts, 3 in each quadrant. Each contains a single spherical concretion. Velum well developed. There are 4 straight, narrow, radial tubes, and a slender, circular vessel. Manubrium very short and square in cross-section. The gonads are developed upon the outer halves of the 4 radial-canals. Ova of female large and prominent.

The entodermal lamella of the bell displays a decided green tinge. The entoderm of the stomach, gonads, and tentacle-bulbs is of a decided yellow-green.

Young medusa.—In the smallest medusa observed the diameter of the bell was 1 mm. There were 4 tentacles, but 2 of them were much more developed than the others. There were only 4 lithocysts, one in each quadrant. The gonads had begun to develop upon the radial-canals very close to the circular vessel.

This medusa is very common upon the southern coast of New England, at Newport Harbor, Rhode Island, and Buzzard's Bay, Massachusetts. A single specimen was found in Charleston Harbor, South Carolina, in 1898; and at Tortugas, Florida, in June, 1902. The medusa makes its appearance at Newport in July and continues to be abundant until the last week of September. Bigelow has found this medusa in Acapulco Harbor, on the west coast of Mexico.

Eucheilota duodecimalis var. parvum.

Dipleuron parvum, Brooks, 1882, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 139.

This variety resembles *E. duodecimalis* in all respects excepting that the gonads are developed upon only 2 of the radial-canals. The gonads are spherical in shape and found upon 2 diametrically opposite radial-canals, near the circular vessel.

This form was found by Brooks at Beaufort, North Carolina, from June until August, and in 1904 I found it in a surface-tow taken early in December, off Cape Fear, North Carolina. It appears to be a local race or variety of *E. duodecimalis*.

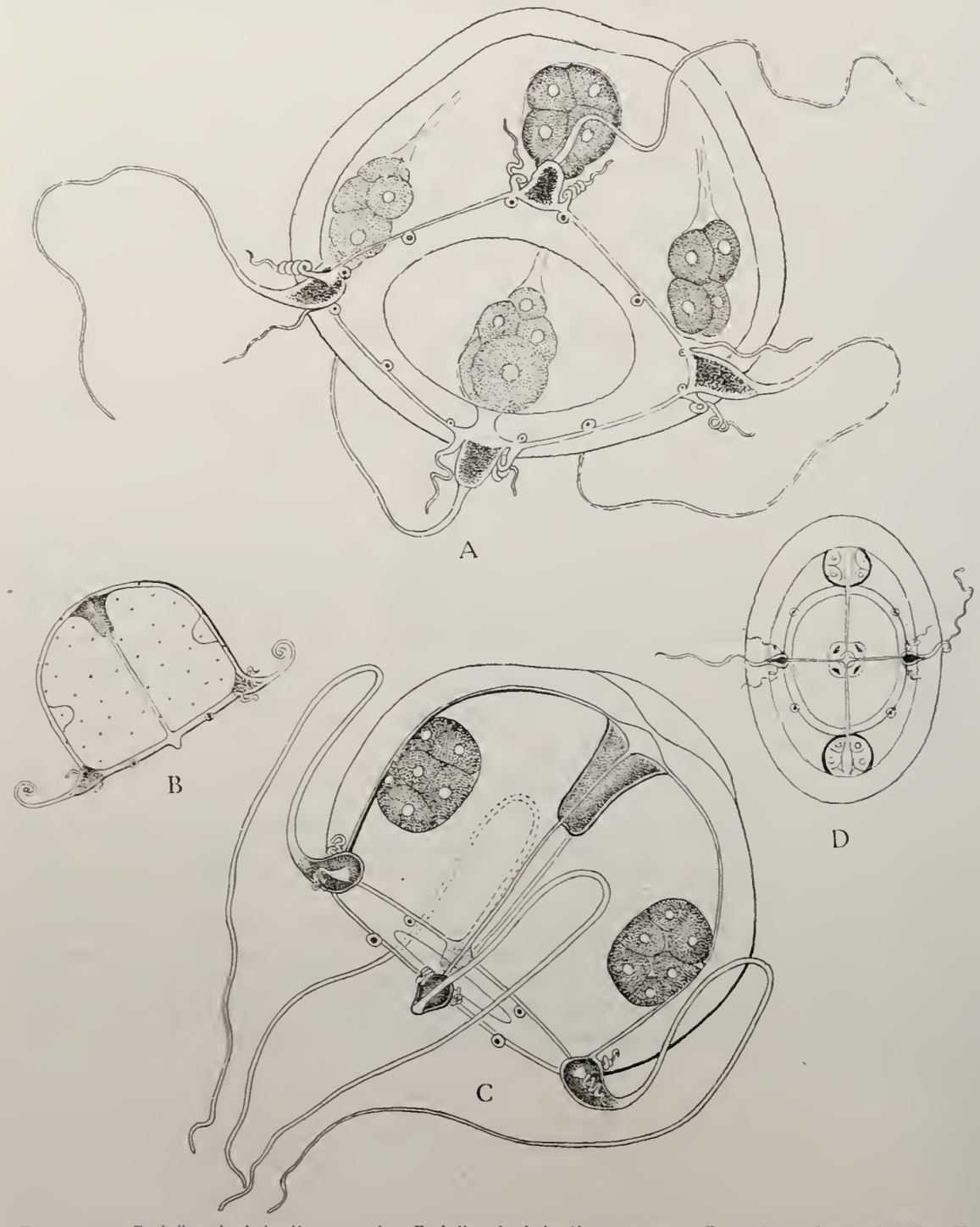


Fig. 151a—A, *Eucheilota duodecimalis;* B, C and D, *Eucheilota duodecimalis* var. *parvum*. Drawn by the late Prof. William K. Brooks at Beaufort, North Carolina, and presented by the Department of Biology of Johns Hopkins University for publication in this work.

Eucheilota maculata Hartlaub.

Eucheilota maculata, Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 193; *Ibid.*, 1897, Neue Folge, Bd. 2, p. 499, taf. 20, fign. 4–8.

(?) *Campanulina hincksii*, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommis. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 496, taf. 21, fig. 1–17; taf. 22, fign. 11 (hydroid and young medusa of (?) *Eucheilota maculata*).

Mature medusa, Eucheilota maculata.—Bell somewhat flatter than a hemisphere, about 13 mm. wide. Gelatinous substance thick above, but thin at sides of bell. 16 to 30 tentacles with well-developed, tapering, basal bulbs, flanked by cirri. These tentacles are about three times as long as bell-diameter. Cirri arise from the bell-margin between the tentacles. The lithocysts are upon the bell-margin alternating with the tentacles. Each lithocyst usually contains 5 or 6 concretions, but there may be as many as 10. Stomach short, 4 well-developed, recurved lips. The 4 linear gonads are developed upon the outer two-thirds of the 4 radial-canals, but do not extend to the ring-canal.

The tentacle-bulbs and gonads are light reddish-brown. On each interradial wall of the stomach there is a large black "ocellus-like" spot.

Found at Helgoland, German Ocean, from August until October.

As Hartlaub states, the hydroid of this species is probably *Campanulina hincksii*. Both hydroid and medusa are well described, in detail, by Hartlaub, 1897.

(?) *Young medusa immediately after being set free from the hydroid.*—Bell 0.4 mm. wide and quite high, rounded with thin walls. 4 long, radial tentacles with thick bulbs, and 4 short interradial cirri. 8 adradial lithocysts each with 1 concretion. Velum wide. 4 narrow radial canals. Manubrium short, tapering, with 4 simple lips. No peduncle. Base of the stomach and tentacle-bulbs are yellowish-brown.

The hydroid *Campanulina hincksii* Hartlaub is distinguished chiefly by its having as many as 5 medusa-buds in each gonangium. The stems are about 5 mm. high, with long, cylindrical hydranths, each with 16 to 20 long, filiform tentacles. Helgoland, German Ocean, July. Described in detail by Hartlaub, 1897.

Eucheilota paradoxica Mayer.

Plate 37, figs. 3–3″.

Eucheilota paradoxica, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 56, figs. 134–136, plate 40; 1904, Museum Brooklyn Institute Mem. Nat. Sci., vol. 1, p. 16, plate 3, figs. 17, 18; plate 7, fig. 65.

Mature medusa.—Bell about 4 mm. in diameter, and in shape fuller than a hemisphere, with a slight apical projection. 4 large, radially situated tentacles, each flanked by 2 short coiled cirri. The basal bulbs of these tentacles are large and hollow. There are also 4 interradial, rudimentary tentacle-bulbs, each flanked by a pair of cirri. 8 adradial lithocysts, 2 in each quadrant, each lithocyst bearing a single concretion. 4 straight, slender radial-canals in the middle of each of which the small, swollen gonads are situated. Manubrium small and flask-shaped, with 4 simple lips. Color of entoderm of stomach, gonads, and tentacle-bulbs dull milky-green.

In the young medusa, the gonads are adjacent to the manubrium, but they finally migrate down the radial-canals so as to come to lie upon the middle of each canal. Medusa-buds arise from these gonads. When set free each medusa has 4 well-developed, radially situated tentacles as in the adult, but the interradial tentacle-bulbs lack lateral cirri (plate 37, fig. 3). A number of budding medusæ were killed in Flemming's fluid and sectioned, and it appears that both entoderm and ectoderm of the gonad of the parent take part in the formation of the bud which is thus formed, as are the medusa-buds of *Sarsia* or those of the hydroids (plate 37, fig. 3″). Even before they are set free the gonads of the daughter medusæ begin to develop medusa-buds.

This and *Eirene medusifera* are the only known Leptomedusæ which develop medusa-buds directly upon their gonads, although *Phialidium mccradyi* Brooks develops hydroid blastostyles in this situation. Also Keferstein, 1863 (Zeit. für wissen. Zool., Bd. 12, p. 28, taf. 2, fig. 9), describes an *Epenthesis* from St. Vaast, coast of Normandy, under the name of *Eucope gemmigera*, and figures a medusa-bud arising from an interradial side of the stomach. In his paper, however, he states that he did not observe whether the medusa-bud arose from the upper part of the stomach or from the radial-canal. He states that the medusa is abun-

dant, yet he found only a single individual with the medusa-bud. It is possible that this so-called medusa-bud may have been a parasitic *Halcampa* (?).

Genus MITROCOMA Haeckel, 1864.

Mitrocoma, Haeckel, 1864, Jena. Zeitschrift für Naturwiss., Bd. 1, p. 332.—Hertwig, O. und R., 1878, Nervensyst. und Sinnesorgane der Medusen, p. 81, taf. 6, fign. 10, 11, 14.—Metschnikoff, 1886, Embryol. Studien an Medusen, Wien, pp. 23, 37, 54, 75, 82, taf. 3, fign. 20–33; taf. 4, fign. 1, 16 (development showing that *Cuspidella* is the hydroid).—Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 589.
Halopsis (*cruciata*), Agassiz, A., 1865, North Amer. Acal., p. 102.
Tiarops, Romanes, 1876, Journ. Linnean Soc. London, vol. 12, p. 526.
Phialis+Mitrocomium+Mitrocomella+Mitrocoma, Haeckel, 1879, Syst. der Medusen, pp. 181, 184, 188.
Halopsis, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 57, taf. 6, fign. 3–6.
Mitrocomella, Browne, 1903, Bergens Museums Aarbog, No. 4, p. 17.
Cuspidella (hydroid), Hincks, 1868, Hist. British Hydroid Zooph., p. 209.

This genus was founded by Haeckel, 1864, for *Mitrocoma annæ*, of the Mediterranean (and Atlantic ?).

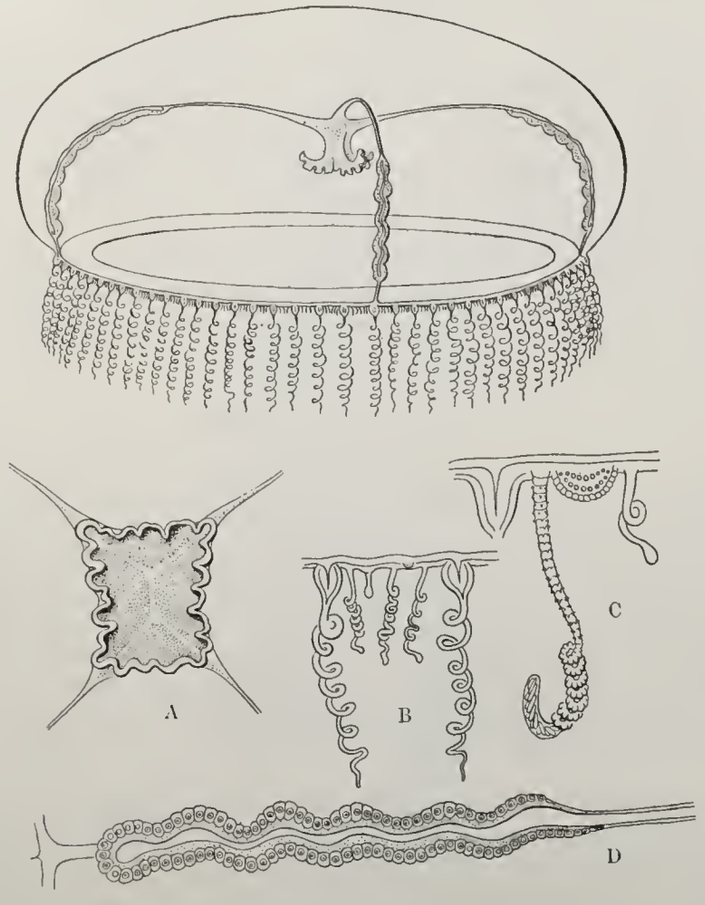


Fig. 152.—*Mitrocoma annæ*. From life, by the author. Zoological Station, Naples, January, 1908.
A. Oral view of open mouth. *B* and *C*. Parts of bell-margin showing cirri and otocysts. *D*. Female gonad.

GENERIC CHARACTERS.

Eucopidæ with 8 or more lithocysts which consist of open folds, or pockets, of the velum, and contain numerous (3 or more) concretions. There are numerous cirri. The 4 gonads are developed upon the 4 radial-canals. There is no well-developed peduncle and there are 4 prominent lips. The hydroid is *Cuspidella* Hincks, 1866.

We include within this genus a number of Eucopidæ which have from 8 to 80 or more large, open lithocysts, each of which usually contains a large number of concretions. The tentacles vary in number in the different species from 8 to 200, or more. It seems inexpedient to draw any generic distinctions between these various species based upon the number of lithocysts or of

tentacles. Should we attempt to do so it would be necessary to erect a new genus for almost every one of the known species, as has practically been done by Haeckel, 1879. We prefer to place all these forms under one genus on account of their close relationship and resemblances in all respects excepting in the absolute number of the lithocysts and tentacles, allowing these to serve as specific distinctions.

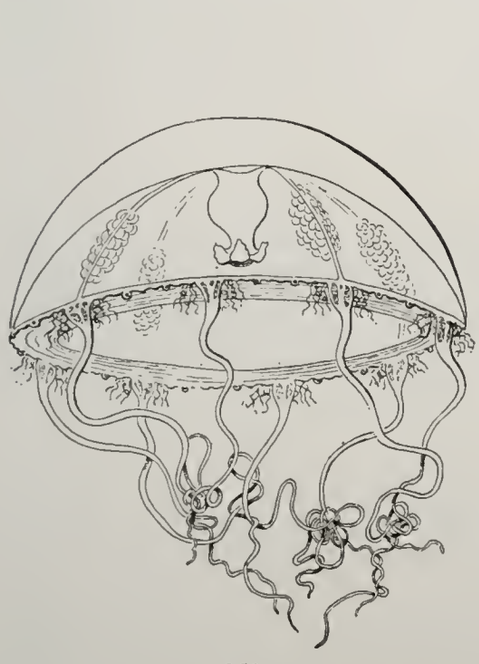
The cirri in *Mitrocoma* resemble those of *Laodicea* in that they arise from the exumbrella at a little distance above the upper nerve-ring, and their cores consist of entodermal cells which are directly continuous with the entoderm of the circular canal (see Maas, 1893, p. 58, taf. 6, fig. 5).

Mitrocoma is distinguished from *Tiaropsis* by the absence of ocelli in the entoderm of the circular canal. Also in *Tiaropsis* there are no cirri.

Mitrocoma is a good connecting link between the Eucopidæ and the Thaumantiadæ, for it possesses marginal cirri similar in structure to those of the Thaumantiadæ, while the presence of lithocysts places it among the Eucopidæ. Metschnikoff, 1886, points out the close relationship between the hydroids of *Laodicea* and of *Mitrocoma*.

It seems possible that the genus *Halopsis* of the Æquoridæ may have arisen from some form of *Mitrocoma* through the multiplication of the radial-canals.

Metschnikoff, 1886, reared the larvæ produced from the eggs of *Mitrocoma annæ* of the Mediterranean and they developed into hydroids having the characters of *Cuspidella* Hincks.



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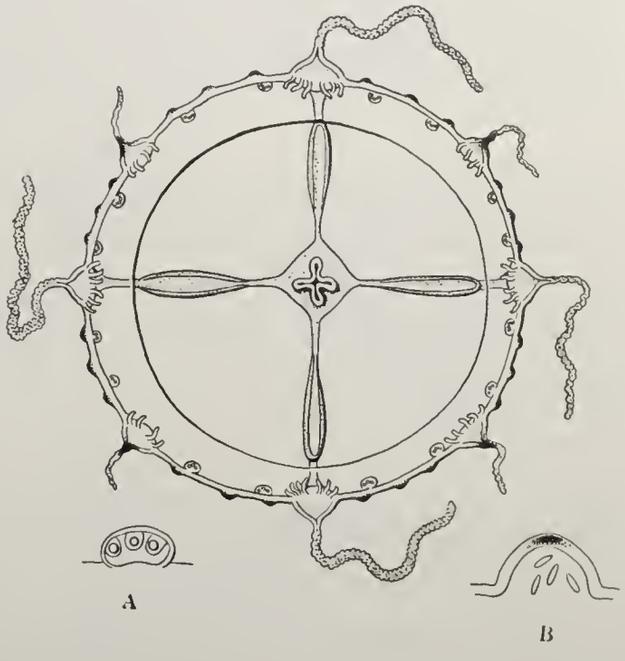


154.

Fig. 153.—*Mitrocoma cirrata* (*Mitrocomium cirratum*), after Haeckel, 1879.
Fig. 154.—*Mitrocoma cirrata*, from life, by the author. Zoological Station, Naples, Dec. 10, 1907.
A. Lithocyst. B. One of the ectodermal pigment spots on bell-margin.

Mitrocoma annæ Haeckel.

Mitrocoma annæ, Haeckel, 1864, Jena. Zeitsch. für Naturwissen., Bd. 1, p. 332; 1879, Syst. der Medusen, p. 189, taf. 10, fign. 1–13.—Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 37 (segmentation), 54 (formation of entoderm), 75 (development of hydroid), 82 (polypites), taf. 3, fign. 20–33; taf. 4, fign. 1–16.
Halopsis annæ, Metschnikoff, E., 1870, Verhandl. Gesell. Freunde Naturwissen. Moskau, p. 355, taf. 4, fig. 7.
(??) *Halopsis cruciata*, Agassiz, A., 1865, North Amer. Acal., p. 102, figs. 151, 152.
Non Mitrocomium annæ, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 606.

Bell flatter than a hemisphere, 30 to 40 mm. wide, with thick gelatinous walls. 60 to 100 long, slender tentacles with conical basal bulbs. 200 to 400 marginal cirri between the tentacles. 60 to 100 lithocysts, each consisting of an open fold of the velum containing about 20 concretions in 2 crescentic rows. Velum narrow. 4 straight, slender radial-canals. Stomach small, 4-sided with 4 recurved lips, having folded margins. The manubrium is only one-

eighth to one-tenth as wide as bell-diameter, and about one-third as long as depth of bell-cavity. The 4 gonads are linear and developed upon the outer halves of the 4 radial-canals, not touching the ring-canal. Stomach, gonads, and tentacle-bulbs sulphur-yellow.

Found in the Mediterranean, at Messina, Villafranca, and Naples. Quite common at Naples during January, 1908. (See text-figure 152.)

Metschnikoff, 1886, reared the hydroid of this medusa from the egg. The egg is 0.14 mm. in diameter, and is laid between 9 and 10 in the morning in January. Segmentation is total and equal, and a spindle-shaped, one-layered blastula is formed. The entoderm arises from cells which migrate singly into the blastula cavity from the narrow hinder end of the larva, and which finally fill it with cells. The larva becomes ciliated and nematocyst-cells develop in the ectoderm of its posterior end. 2 or 3 blastulæ sometimes fuse and develop into a single, somewhat irregular planula. Sometimes the whole larva becomes attached, forming a hydrorhiza from which the polypites grow out, but in other cases the larva becomes attached only by its forward end, the hinder end developing into a polypite. The hydroid is a *Cuspidella* quite similar to that described by Hincks, 1868 (Hist. British Hydroid Zoophytes, p. 209, plate 39, fig. 4). The oral cone of the polypite is, however, flatter and more dome-like than shown by Hincks. The tentacles arise in a single zone, are filiform, all of about the same length, and lack a basal web. The hydrothecæ are cylindrical, wide, and elongate, and arise at intervals from a linear, creeping hydrorhiza. The orifice of the hydrotheca bears a number of sharp-pointed, triangular teeth which may be drawn together, thus closing the opening with a conical diaphragm. The polypite may be extended beyond this opening, or withdrawn within the hydrotheca. The reproductive calycles are unknown.

Mitrocoma minervæ Haeckel.

Mitrocoma minervæ, Haeckel, 1879, Syst. der Medusen, p. 189.

This medusa is possibly identical with *Mitrocoma annæ*, but is said to have a flatter bell and relatively larger stomach and lips. 120 to 160 tentacles, and the same number of lithocysts and cirri. Each lithocyst is an open fold of the velum containing 8 to 12 concretions in a single row. 4 gonads, linear, developed upon nearly the entire lengths of the 4 radial-canals, leaving a short length of the inner ends of the radial-canals free. Found off the south coast of Africa (Indian Cape Stream ?). Development unknown.

Mitrocoma cirrata.

Euchilota, sp., Hertwig, O. und R., 1878, Nervensystem der Medusen, pp. 70, 72, 90, taf. 7, fign. 16, 17; taf. 10, fig. 13.
Mitrocomium cirratum, Haeckel, 1879, Syst. der Medusen, p. 182, taf. 11, figs. 9–11.
(?) *Mitrocomium assimile* (young medusa), Browne, 1905, Pearl Oyster Fisheries Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 137, plate 1, fig. 3.

Bell nearly hemispherical, 16 mm. wide. 8 tapering tentacles hardly as long as bell-diameter and with large basal bulbs, flanked on each side by 3 or 4 spiral cirri. 30 to 40 marginal warts, 16 lithocysts, each with 2 to 6 (usually 3) concretions. No cirri on bell-margin except upon the sides of the 8 tentacle-bulbs. Velum narrow. 4 narrow, simple radial-canals. Stomach short, urn-shaped, with 4 simple lips, and no peduncle. 4 spindle-shaped gonads on outer halves of the 4 radial-canals not touching the ring-canal.

Stomach, gonads, and tentacle-bulbs milky-yellow to brownish. The marginal warts have black, ectodermal pigment. (See text-figures 153 and 154.)

Found in the Mediterranean, at Corfu and at Naples. Rare.

Browne, 1905, describes a medusa from Ceylon of which he obtained only 1 specimen, but which closely resembles *M. cirratum*, and may be a young stage of the latter. It is described as being 2 mm. wide, 1.5 mm. high, with bell-walls fairly thick. Only 4 radially placed tentacles with basal bulbs flanked by cirri. 20 to 28 marginal warts, 5 lithocysts, each with 2 to 3 concretions. Gonads on outer halves of the radial-canals, each parted longitudinally in the middle by the radial-canal upon which the gonad is developed. Color yellowish and opaque.

Further studies are required to determine whether this Ceylonese medusa may or may not be identical with the Mediterranean form. Their general resemblance is very close.

Mitrocoma cruciata.

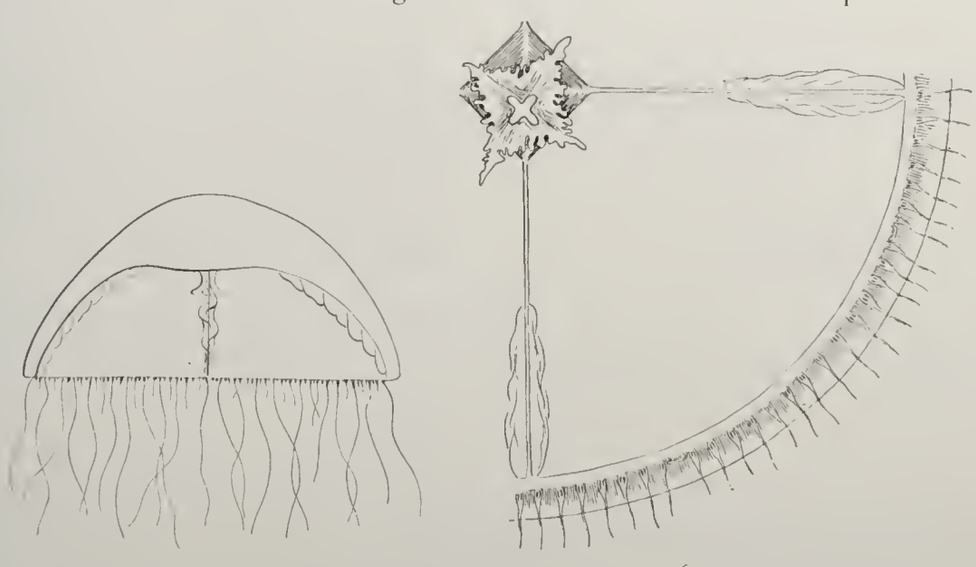
Halopsis cruciata, Agassiz, A., 1865, North Amer. Acal., p. 102, figs. 151, 152.
Phialis cruciata, Haeckel, 1879, Syst. der Medusen, p. 181.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, p. 50.
(??) *Mitrocoma annæ*, Haeckel, 1879, Syst. der Medusen, p. 189, taf. 10, figs. 1–13.

Bell hemispherical, 40 to 50 mm. in diameter. About 100 slender tentacles with well-developed basal bulbs, tentacles not over 25 mm. in length. There are numerous cirri between the tentacles. There are 12 large lithocysts, 3 in each quadrant, each containing 5 or more concretions. Velum well developed. There are 4 narrow, straight, radial tubes. Manubrium very small, no peduncle. There are 4 recurved lips. The 4 gonads are developed upon the outer halves of the 4 radial-canals. They are slightly sinuous, being somewhat longer than the parts of the radial-canals upon which they are situated. Ova in female large and prominent. The genital organs and bell are pink in color. This medusa was found at Nahant, Massachusetts, in June. It has not been seen since A. Agassiz studied it in 1862 and 1864.

Mitrocoma megalota.

Halopsis megalotis, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 57, taf. 6, fign. 3–6.

Bell flat, shield-shaped, with firm gelatinous substance, 40 mm. wide, 5 mm. high. About 100 very contractile tentacles. These are lash-like, tapering, with large, swollen, hollow, basal bulbs, and only about one-eighth as long as bell-radius. About 800 very short, solid cirri, arising from bell-margin between the tentacles. 8 adradial lithocyst-pouches, similar in structure to those of *Mitrocoma annæ*. These lithocysts are very elongate, open pouches, and lie upon the subumbrella side of the margin at the base of the velum. Each pouch contains a



155. 156.

Fig. 155.—*Mitrocoma cruciata* (*Halopsis cruciata*), after A. Agassiz, in North American Acalephæ.
Fig. 156.—*Mitrocoma megalota*, after Maas, in Ergeb. Plankton Expedition.

number of ectodermal concretions. There are no ocelli. Velum very narrow, its muscles weakly developed. There are 4 narrow radial-canals and a simple, slender circular vessel. The large stomach is quadratic at base, a radial-canal arising from each of the 4 corners. The mouth is at the extremity of a short neck and is surrounded by 4 large, folded, crenated lips. The gonads are swollen, linear, and lie upon the outer thirds of the 4 radial-canals. Each gonad is developed upon both sides of its radial-canal, leaving the middle line of the canal free. Found by the Plankton expedition off northwest coast of Scotland in July.

Mitrocoma discoidea Torrey.

Mitrocoma discoidea, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 17, fig. 4.

Bell flatter than a hemisphere, 45 mm. wide. 180 to 240 short tentacles with swollen basal bulbs. 20 to 60 lithocysts with numerous concretions in 2 to 3 rows. Marginal cirri

may be as numerous as tentacles, but are readily lost. Manubrium small and short, with 4 narrow, frilled lobes. Gonads narrow, on nearly the entire lengths of the 4 radial-canals leaving both ends of each canal free. Ring-canal yellow-green, tentacle-bulbs purple, edges of lips with a single row of faint purple spots. Common in surface hauls off San Diego, California, from May to July.

This species is readily distinguished by its flat, discoidal bell, three or four times as broad as high. It differs from *Mitrocoma annæ* in its color and in having fewer marginal cirri.

Mitrocoma polydiademata.

Tiaropsis polydidemata, Romanes, 1876, Journal Linnean Soc. London, vol. 12, p. 524; *Ibid.*, 1877, vol. 13, plate 15, fig. 3.
Mitrocomella polydiadema, Haeckel, 1879, Syst. der Medusen, p. 185.
Mitrocomella polydidema, Browne, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 279.
Mitrocomella fulva (young medusa), Browne, 1903, Bergens Museums Aarbog, No. 4, p. 17, plate 1, fig. 3; plate 3, figs. 1, 2.
Mitrocomella polydiademata, Browne, 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 767.

Bell nearly hemispherical and about 12 mm. wide. About 48 tentacles, long and slender, with conical basal bulbs. 300 or more long, marginal cirri arising from bell-margin between tentacles, not from the sides of the exumbrella; 4 to 10 of these cirri between each successive pair of tentacles. Each cirrus terminates in a small, oval cluster of nematocysts. 16 marginal lithocysts, each consisting of a large open fold of the velum containing about 30 concretions. Velum narrow; 4 straight, narrow radial-canals. The manubrium is very small, with a quadrangular base, flat, and with 4 small folded lips. The 4 gonads are linear and extend over the outer 0.75 of the radial-canals.

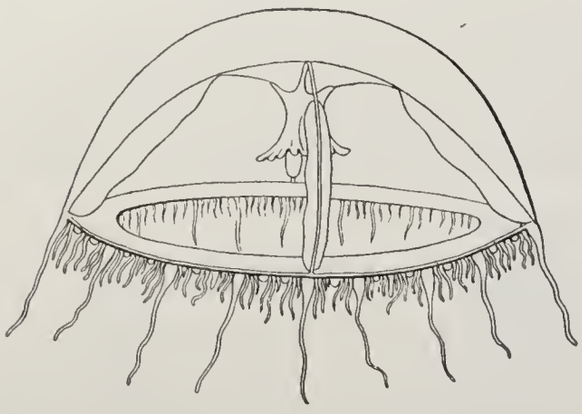


Fig. 157.—*Mitrocoma polydiademata*, after Browne, in Bergens Museums Aarbog, 1903.

The stomach, gonads, and tentacle-bulbs are rich purple-red, the gonads being occasionally yellowish-brown.

The medusa is rare and occasional, and has been taken in a few localities off the British and Norwegian coasts; Cromarty Firth, Scotland; Port Erin, Isle of Man; Plymouth England; and Byfjord, Norway. It occurs in spring and summer. Hydroid unknown.

Mitrocoma lendenfeldi.

Mitrocomium annæ, von Lendenfeld, 1884, Proc. Linnean Soc. New South Wales, vol. 9, p. 606, plate 29, figs. 56–60.

Bell flat, cone-shaped; 5 mm. wide and 2.5 mm. high. 8 tentacles, 4 radial, 4 interradial; 1.5 times as long as diameter of bell. These tentacles have globular basal bulbs, flanked on either side by a cluster of short cirri which arise from the bell-margin and from the sides of the basal bulbs; a black ocellus on outer side of each tentacle-bulb. 16 marginal lithocysts upon the bell margin, 2 between each successive pair of tentacles. "No marginal bulges." Stomach small, globular, with 4 dark interradial spots; it is connected with the bell by a narrow peduncle and is only about one-third as long as depth of bell-cavity. There are 4 extended, simple lips, and 4 oval gonads on the 4 radial-canals near the ring-canal. Each gonad is attached to the radial-canal by a narrow neck. Gonads pale greenish-yellow. Entoderm of stomach brown. Ocelli black. Port Jackson, New South Wales, Australia. Rare, found from April to June. This species is certainly not identical with Haeckel's *M. annæ*.

Genus CAMPALECIUM Torrey, 1902.

Campalecium, Torrey, 1902, Univ. California Publ. Zool., vol. 1, p. 48.—Hartlaub, 1905, Zoolog. Jahrbüchern, Suppl. 6, p. 602.

Hydroid.—Hydrothecæ arranged alternately on hydrocaulus, shallow, saucer-shaped, incapable of containing the large hydranths in contraction. Margin smooth; hydranth with conical proboscis and one whorl of filiform tentacles.

Gonosome.—Medusoid 2 to 5 linear series. Medusæ each with 4 tentacles, 2 large, 2 small. Manubrium conical. Lithocysts (?) It is doubtful whether medusæ be set free or not. The only species is *Campalecium medusiferum* Torrey, H. B., 1902 (*loc. cit.*, p. 48, plate 3, figures 26 to 29), from Long Beach, California. The free medusæ are not known. This is the only Halecium-like hydroid which produces medusæ in its gonangia.

Genus STAUROPHORA Brandt, 1834.

Staurophora, Brandt, 1834, Prodromus animalium ab H. Mertensio, etc., separate, p. 30; 1838, Mém. Acad. Impériale des Sci. St. Pétersbourg, Sci. Naturelles, sér. 6, tom. 4, p. 399.—Agassiz, L., 1849, Memoirs Amer. Acad., New Series, vol. 4, p. 300.—Lesson, 1843, Hist. Zooph. Acal., p. 297.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351.—Agassiz, A., 1865, North Amer. Acal., p. 136.—Haeckel, 1879, Syst. der Medusen, p. 148.—Hartlaub, 1897, Hydromedusen Helgolands, p. 484.—Wagner, 1885, Wirbellosen des Weissen Meeres, p. 80.

Staurostoma (in part), Haeckel, 1879, Syst. der Medusen, p. 130.

Staurostoma (young stage), Haeckel, 1879, Syst. der Medusen, p. 130.

Staurostoma, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 65.—Linko, 1900, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 8, tome 10, No. 3, p. 4.

Staurostoma=*Staurophora*, Birula, 1896, Annuaire Musée Zool. Acad. Imp. Sci. St. Pétersbourg, tome 1, p. 342.

Staurophora=*Staurostoma*, Browne, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, p. 469.

GENERIC CHARACTERS.

Eucopidæ in which the mouth is a cruciform, gutter-like slit extending down the 4 radial-canals nearly to the bell-margin. The 4 radial-canals are therefore open grooves bordered on their edges by curtain-like walls. These "stomach" walls contain the gonads. The radial-canals may give rise to numerous short, blindly-ending side branches. There are numerous tentacles, lithocysts, and ocelli.

The lithocysts in *Staurophora* are so minute and so deeply sunken within the ectoderm of the subumbrella side of the velum, that they were overlooked until Linko, 1900, announced that he had discovered them, upon sectioning the medusa. Many and possibly all of the marginal clubs seen in well-grown specimens of *Staurophora* develop ultimately into tentacles.

The type species of this genus is *Staurophora mertensii* Brandt, of the Aleutian Islands, North Pacific. This medusa appears to be an Arctic species and to be identical with *Staurophora laciniata* L. Agassiz, of the North Atlantic. "*Staurostoma arctica*" of Haeckel appears to be a young or abortive stage of *Staurophora laciniata*, in which the radial-canals have folded or frilled margins instead of feathered edges as in *Staurophora*. "*Staurostoma*" is also said to have a mouth which extends only part way down the radial-canals instead of reaching almost to the bell-margin as in *Staurophora*. The *Staurophora* of the New England coast passes through a "*Staurostoma*" stage. Haeckel's single specimen of *Staurostoma arctica* is described as being larger than *Staurophora*, but possibly it was abortive in the development of its mouth parts and radial-canals.

Haeckel places "*Staurostoma*" among the Thaumantiadæ, and *Staurophora* among his Cannotidæ, thus widely separating that which I believe to be the young from the adult medusa. Linko, 1900, finds that "*Staurostoma*" has marginal lithocysts. It must apparently therefore be classified among the Eucopidæ, although Browne failed to find lithocysts in the Antarctic *Staurophora*.

Staurophora bears a close superficial resemblance to *Ptychogena* but is distinguished at once by the ocelli on the velar sides of the tentacle bulbs, these being absent in *Ptychogena*.

Staurophora mertensii Brandt.

Plate 26, figs. 4–9 (Vol. 1).

Staurophora mertensii, Brandt, 1838, Mém. Acad. Imp. Sci. St. Pétersbourg, Sci. Nat., Sér. 6, tome 4, p. 400, taf. 24, 25.

Staurophora laciniata, Agassiz, L., 1849, Memoirs American Academy, New Series, vol. 4, p. 300, plate 7, figs. 1–15.—Stimpson, 1853, Marine Invert. Grand Manan, p. 11.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 351.—Agassiz, A., 1862, Proc. Boston Soc. Nat. Hist., vol. 9, p. 90, figs. 1–3; 1865, North Amer. Acal., p. 136, figs. 215*a*–219.—Hartlaub, 1897, Wissen. Meeresuntersuch. Helgoland (Hydromde. Helgolands), Heft 1, Abt. 2, p. 484, taf. 16*c*, fign. 5, 6, 9, 10; taf. 22, fig. 2.—Wagner, 1885, Wirbellosen des Weissen Meeres, p. 80, taf. 4, fign. 14–20.—Hargitt, 1902, American Naturalist, vol. 36, p. 553.

Staurophora keithii, Peach, 1867, Journ. Roy. Inst. Cornwall, vol. 2, p. 358, plate 2.

Staurosotoma laciniata+*Staurophora mertensii*+*Staurostoma arctica*, Haeckel, 1879, Syst. der Medusen, pp. 130, 131, 149.

Staurostoma laciniata, Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 43, 1 fig.

Staurophora mertensi, Bedot, 1905, Revue Suisse de Zool., tome 13, p. 147 (review of all papers to 1850).

Staurophora arctica, Levinsen, 1893, Vid. Meddel. Nat. For. Kjöbenhavn, Ser. 5, Bd. 4, p. 145.—Hartlaub, 1897, Meeresuntersuch. Helgoland, Neue Folge, Bd. 2, Heft 1, Abt. 2, p. 486.

Staurostoma arctica, Linko, 1900, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 8, tome 10, No. 3, p. 4, taf. 2, fign. 22–25 (ocelli and otocysts); 1904, Zool. Anzeiger, Jahrg. 28, p. 218.

Staurostoma arctica, Haeckel=*Staurophora laciniata*, L. Agassiz, Birula, 1896, Annuaire Musée Zool. Acad. Imp. Sci. St. Pétersbourg, tome 1, p. 342.

Staurophora laciniata, etc., Browne, 1907, Annals and Mag. Nat. Hist., ser. 7, vol. 20, pp. 470–472.

Mature medusa (plate 26, fig. 6).—Bell 100 to 200 mm. wide, and 30 to 50 mm. high; with thick gelatinous substance. Aboral side smoothly rounded. 200 to 300 very short marginal tentacles and a variable number of elongate, club-like, marginal appendages, probably all of which are merely developing tentacles. Tentacle-bulbs hollow and conical, the free ends of tentacles usually coiled in close helices. There is a single, small, dark-brown ocellus in the ectoderm of each tentacle-bulb. These ocelli lie on the inner sides of the tentacle-bulbs, close to the insertion of the velum. The ocelli are innervated by the subumbrella nerve-ring. The marginal clubs are hollow and their lumen is continuous with the entoderm of the circular vessel. These marginal clubs are of various lengths (plate 26, fig. 5), and may usually be seen in various stages of development into tentacles.

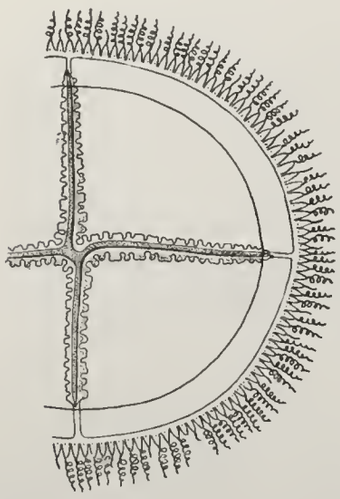


Fig. 158. — *Staurophora mertensii*. Young medusa drawn by the author, from specimen 25 mm. in diameter. Woods Hole, Massachusetts.

Above the base of each tentacle-bulb is a single inclosed lithocyst-cavity containing a spherical concretion. These minute lithocysts lie buried in the ectoderm on the subumbrella side of the bell a short distance above the insertion of the velum. They are innervated by the inner nerve-ring (see Linko, 1900).

The mouth is an enormously elongated, cruciform slit extending down the 4 radial-canals, almost to the bell-margin. The radial-canals are thus converted into open gutters. The edges of the radial-canals give rise to numerous, short, branched, blindly ending diverticula, and the gonads are developed in the ectoderm over these side branches and in the walls of the cruciform lips. Hargitt, 1902, states that actinulæ develop upon the gonads. These lip-walls are short and their free margins are crenated and folded in a curtain-like manner.

The entoderm of the radial-canals and circular canal is milky-white, sometimes slightly yellowish or greenish. The gelatinous substance of the bell is transparent and of a bluish hue. As it floats languidly in the water the opaque entoderm of the 4 canals presents the appearance of a large milky cross.

Young medusa.—In the youngest medusa observed, the bell is hemispherical. There are 8 tentacles; 4 long radial and 4 short interradial. Each tentacle-bulb is provided with a dark-colored ocellus upon its inner side. There are 4 straight-edged, narrow, radial tubes. The manubrium is small and has 4 simple lips.

When the medusa is about 8 mm. in diameter (see vol. 1, plate 26, fig. 7), the tentacles have increased in number and the manubrium has become much larger through the extension of the 4 lips down the radial-canals, and the medusa begins to fulfil the conditions postulated by Haeckel for "*Staurostoma*."

When the animal is about 20 mm. in diameter (plate 26, fig. 4), the bell becomes quite flat and the cruciform mouth has extended about half-way down the 4 radial-canals. In the adult they finally reach the circular vessel and the radial-canals give rise to small, blindly ending, lateral diverticula.

This medusa is abundant north of Cape Cod, but is rarely seen except in early spring upon the southern coast of New England. It makes its appearance in Massachusetts Bay early in April, becomes mature in June, and disappears before the middle of July. At Eastport, Maine, however, they remain common until October. Mature individuals were found in Newport Harbor, Rhode Island, from June 5 to 9, 1895. Hartlaub, 1897, has found this species at Helgoland, and Wagner, Linko, and Birula have obtained it in the seas north of Russia, and Levinsen records it from the coast of Greenland. It is evidently, therefore, an Arctic species, and this fact, together with its similarity to Brandt's figures of *Staurophora*

mertensii of the Aleutian Islands, North Pacific, inclines me to believe that our American *Staurophora* is identical with the Pacific form and should be called *S. mertensii*. A direct comparison of specimens is necessary in order to determine this positively, but the figures published by Brandt might certainly have been drawn from our *Staurophora* of the coast of Maine, United States.

Hartlaub, 1897, finds that the young medusa grows rapidly if fed upon copepods.

Staurophora falklandica Browne.

Staurophora falklandica, Browne, 1908, Trans. Royal Soc. Edinburgh, vol. 46, part 2, p. 235, plate 1, figs. 1–8.

This medusa from the Falkland Islands, South Atlantic, resembles the Arctic *S. mertensii* in all respects excepting that in the single specimen studied by Browne, the small tentacles lack ocelli; they may, however, be young tentacles which are destined later to develop ocelli. The Falkland Islands medusa was 90 mm. wide, with several hundred tentacles, half of which are very short (young?) and alternate with the others. Only the large tentacle-bulbs bear ocelli on their inner sides near the velum. Clubs alternate regularly with the tentacles. Browne failed to find concretions upon sectioning the medusa, but they may possibly have been destroyed by the preservative fluid.

It is possible that this medusa is identical with the Arctic *S. mertensii*, and if this be true, it is one of those remarkable forms whose distribution is bipolar, but which are not known in tropical regions.

Subfamily EUTIMINÆ.

Eucopidæ with 8 adradial lithocysts, stomach mounted upon a long, gelatinous peduncle, tentacles arising from the bell-margin.

Genus SAPHENIA Eschscholtz, 1829.

Saphenia, Eschscholtz, 1829, Syst. der Acalephen, p. 92.—Lesson, 1843, Hist. Nat. Zooph. Acal., p. 325.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 363.—Haeckel, 1879, Syst. der Medusen, p. 193.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 486; *Ibid.*, tome 13, p. 146.—Browne, 1895, Proc. and Trans. Liverpool Biol. Assoc., vol. 9, p. 282; 1896, Proc. Zool. Soc. London, p. 493.
Plancia, Forbes, 1853, Trans. Edinburgh Roy. Soc., vol. 20, p. 311.
Goodsirea, Wright, 1859, Edinburgh New Philosoph. Journ., vol. 10, plate 9.
Siphonorynchus, Metschnikoff, 1870, Verhandl. Gesell. Freunde Naturwissen. Moskau, p. 352.

Eschscholtz, 1829, established this genus for 3 medusæ. The first described is called *Saphenia balearica* and is merely a regenerating *Geryonia*. The second species mentioned is *Saphenia bitentaculata* from the Straits of Gibraltar, and this becomes the type of the genus.

GENERIC CHARACTERS.

Eucopidæ with only 2 well-developed, radially placed tentacles, 180° apart. 8 adradial lithocysts and numerous cirri or marginal warts. Stomach mounted on a gelatinous peduncle. Gonads upon the 4 radial-canals. Hydroid unknown.

These rare and occasional medusæ have all been found in European waters. Cunningham, 1891, is the only naturalist who has ever found a large swarm of them, but he captured some hundreds of specimens of *S. gracilis* off the Eddystone, English Channel, on the night of July 16, 1891.

Saphenia may be regarded as an arrested *Eutima* in which only 2 of the long tentacles are developed. Indeed, Browne goes so far as to state that it is possible that "*Saphenia*" is only a stage in the development of some species of *Eutima*.

Tabular Synopsis of Species of Saphenia.

	S. bitentaculata Eschscholtz, 1829.	S. gracilis=Plancia gracilis Forbes and Goodsir, 1853=Goodsirea mirabilis Wright, 1859. S. mirabilis Haeckel, 1879.*	S. dinema Eschscholtz, 1829=Geryonia dinema Péron et Lesueur, 1809.†
Size of bell in mm.	Globular. 10 to 12 wide, 8 to 10 high.	Hemispherical. 12 to 25 (?) mm. wide.	Conical. 3 wide, 3 high.
Length of peduncle in terms of bell-radius (*r*).	Conical at its base, cylindrical below. About 1.5 *r* long.	As in S. bitentaculata.	Cylindrical, *r* — long.
Length of tentacles in terms of bell-radius (*r*).	4	4±	2
Number of marginal warts.	16 to 24	40±	Numerous. Number?
Number of marginal cirri.	32 to 48 flanking marginal warts and tentacles.	80±	Numerous. Number?
Number of concretions in each lithocyst.	10 to 12	1 to 5. Average 3.	?
Position of gonads.	Developed upon nearly entire length of the 4 radial-canals.	Developed only on peduncle above stomach.	On peduncle.
Size and shape of stomach and lips.	Small, with 4 small lips.	Small, flask-shaped, with 4 small recurved lips.	Small.
Color.	Colorless with whitish gonads.	Colorless save for delicate pink tinge on lips, gonads, stomach.	Colorless.
Where found.	Straits of Gibraltar, Mediterranean.	British coasts, Scotland, Firth of Forth, Sound of Mull, England, Plymouth, Isle of Man.	Atlantic coast of France.

*Distinguished by large number of cirri and small number of concretions in each lithocyst.
†This is probably young of *S. gracilis*.

Saphenia gracilis.

Plancia gracilis, Forbes and Goodsir, 1853, Trans. Edinburgh Royal Soc., vol. 20, p. 311, plate 10, figs. 1–1*e*.
Goodsirea mirabilis, Wright, 1859, Edinb. New Philos. Journal, vol. 10, plate 9, figs. 1–3.
Saphenia mirabilis, Haeckel, 1879, Syst. der Medusen, pp. 192, 654.—Cunningham, 1891, Journ. Marine Biol. Assoc., Plymouth, ser. 2, vol. 2, p. 194.—Browne, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 282; 1896, Proc. Zool. Soc. London, p. 493, plate 17, fig. 3; (?) plate 16, fig. 5.
Saphenia dinema (young medusa ?), Eschscholtz, 1829, Syst. der Acal., p. 93=*Geryonia dinema*, Milne-Edwards, 1849, in Cuvier's Règ. Anim. Zooph., plate 54, fig. 1.

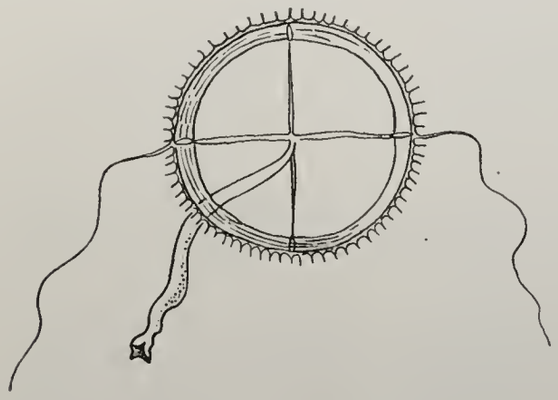


Fig. 159.—*Saphenia* (*Plancia gracilis*), after Forbes and Goodsir, in Trans. Roy. Soc. Edinburgh, 1853.

Wright appears to have overlooked the fact that Forbes and Goodsir had previously described this medusa from the Sound of Mull, Scotland, in 1853, under the name *Plancia gracilis*. The medusa described by Forbes and Goodsir is 8 mm. wide, has about 60 cirri, and 2 long tentacles about as long as the bell-diameter. The peduncle is about 1.5 times as long as the bell-radius. The stomach is small and flask-shaped with 4 short, simple lips. The stomach is pink. For description of *S. gracilis* based upon the accounts of Haeckel, Cunningham, and Browne, see synoptic table of the species of *Saphenia*.

Saphenia bitentaculata Eschscholtz.

Dianæa bitentaculata, Quoy et Gaymard, 1827, Annal. Sci. Nat., tome 10, p. 184, plate 6a, fig. 9.
Saphenia bitentaculata, Eschscholtz, 1829, Syst. der Acal., p. 93.—Haeckel, 1879, Syst. der Medusen, p. 193.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 146 (literature 1829–50).
Geryonia bitentaculata, de Blainville, 1834, Man. Actinologie, p. 287, plate 37, fig. 2.
Siphonorynchus bitentaculatus (young medusa ?), Metschnikoff, E., 1870, Verhandl. Gesell. Freunde Naturwissen. Moskau, p. 352, taf. 5, fig. 5; 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 261.

For description see synoptic table of species of *Saphenia*.

PLATE 39.

Fig. 1. *Eutima mira.* Charleston Harbor, South Carolina, September 11, 1897.

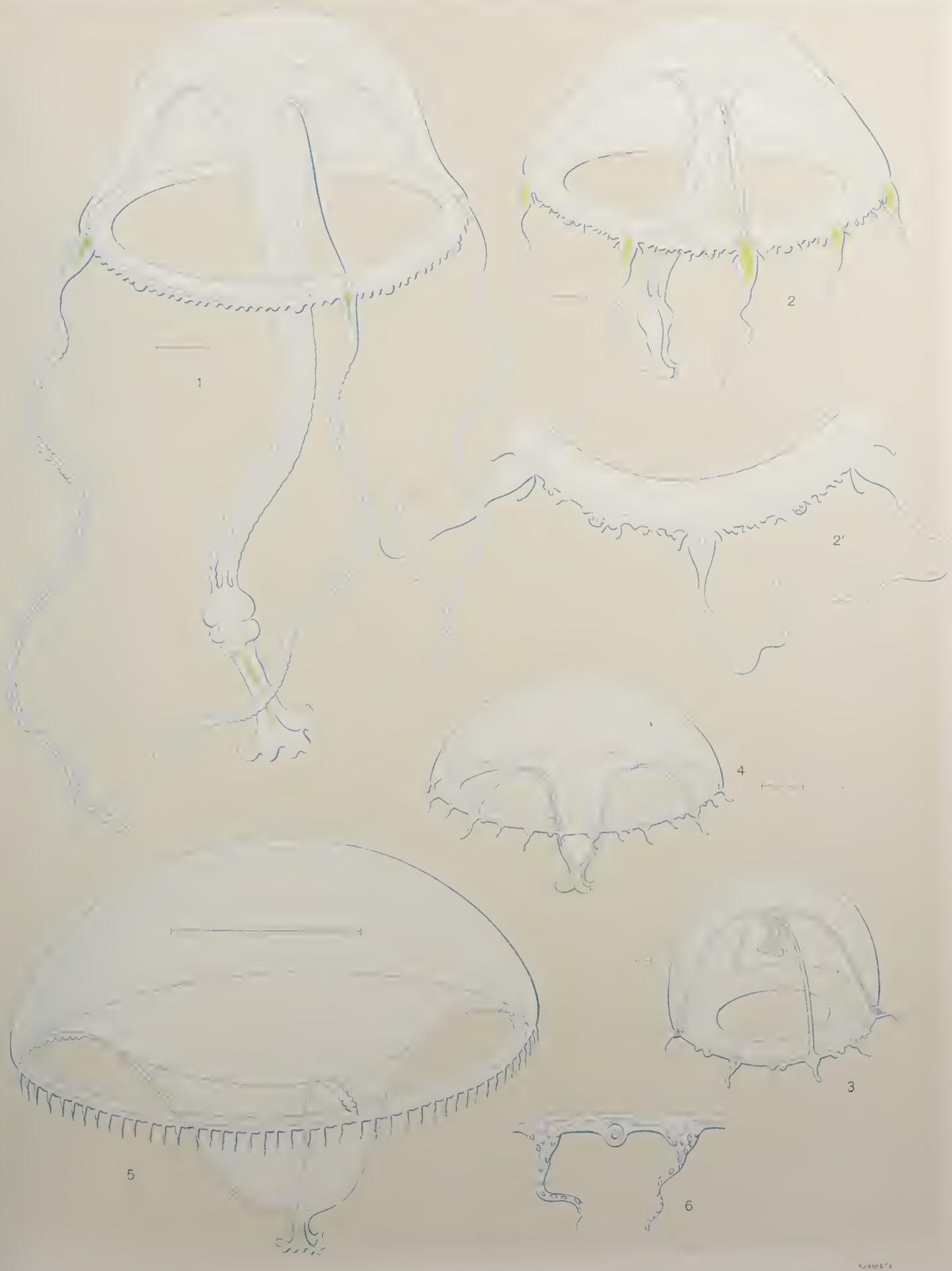
Fig. 2. *Eirene variabilis*, young medusa. Figure 2′, quadrant of the bell-margin of the same medusa. Tortugas, Florida, June 20, 1899.

Fig. 3. *Phortis pyramidalis*, young medusa. Great Abaco Island, Bahamas, March 9, 1893.

Fig. 4. *Phortis pyramidalis*, intermediate stage in the growth of the medusa. Great Abaco Island, Bahamas, March 9, 1893.

Figs. 5 and 6. *Phortis pyramidalis*, mature medusa. Figure 6, a part of the bell-margin of the medusa shown in figure 5. Tortugas, Florida, June, 1897.

Drawn from life, by the author.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Genus EUTIMA McCrady, 1857.

Eutima, McCrady, 1857, Gymn. Charleston Harbor, p. 87.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 363.—Agassiz, A., 1865, North Amer. Acalephæ, p. 116.—Brooks, 1882, Studies Biol. Lab. Johns Hopkins Univ., vol. 2, p. 140.—Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, p. 158.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 165.
Eutima + Eutimeta + Eutimalphes + Octorchis + Octorchandra, Haeckel, 1879, Syst. der Medusen, pp. 190, 194, 196, 197.
Sens. ampl., Eutima, Maas, 1905, Craspedoten Medusen *Siboga* Exped., Monog. 10, p. 34.
Octorchis, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, p. 140.
Campanopsis (hydroid), Claus, 1881, Arbeit. Zool. Inst. Wien, Bd. 4, p. 91, plates 1, 2, 20 figs.

This genus was founded by Mc Crady, 1857, for *Eutima mira* of Charleston Harbor.

GENERIC CHARACTERS.

Eucopidæ with 8 lithocysts, 2 in each quadrant, and with 4 or more well-developed tentacles. There are numerous rudimentary tentacles or marginal cirri. The gonads are situated upon the 4 radial-canals. The stomach is mounted upon a well-developed peduncle. The 4, or 8, gonads are developed upon the radial-canals. The hydroid is *Campanopsis*.

The gonads may be developed upon the sides of the peduncle, or upon the subumbrella, or upon both places at one and the same time. Moreover, the gonads which begin to develop upon the subumbrella and the peduncle may eventually grow toward and fuse with each other, thus forming a single long gonad upon each radial-canal. Thus the medusæ may be found with 4 gonads, one on each radial-canal or 8 gonads, 2 on each canal. The tentacles may increase with age from 4 to more than 16. When young the medusæ usually have neither marginal nor lateral cirri. Different individuals of the same species may be colorless or highly colored, green or bluish-green being prevalent.

Haeckel has constructed 5 genera out of McCrady's *Eutima* as follows: *Eutima*, 4 tentacles, 4 gonads; *Eutimeta*, 8 tentacles, 4 gonads; *Eutimalphes*, more than 8 tentacles, 4 gonads; *Octorchis*, 8 tentacles, 8 gonads; *Octorchandra*, more than 8 tentacles, 8 gonads.

Eutima, *Eutimeta*, and *Octorchis* Haeckel appear, at least in some cases, to be merely developmental stages in the ontogeny of *Eutimalphes* and *Octorchandra*, and I agree with Maas, 1905, in believing that the definition of the genus should be amplified. The hydroid of *Eutima* (*Campanopsis*) has been reared by Claus, 1881, and Brooks, 1886.

The species of *Eutima* have been founded upon minute distinctions which, in view of the considerable degree of variability observed in individual medusæ, make it certain that many of them are mere growth-stages or local variations. This is especially true of the American authors who have upon insufficient evidence greatly multiplied the "species" of these medusæ. It is probable that *E. limpida*, *gracilis*, and *emarginata* are identical with *E. mira*.

Eutima is closely related to *Eirene*, but in *Eirene* there are more than 8 lithocysts.

The synoptic table, on page 296, will serve to illustrate the minuteness of the distinctions upon which authors have endeavored to separate these very variable medusæ into distinct species.

Eutima mira McCrady.

Plate 39, fig. 1; plate 40, figs. 3 and 3′.

Eutima mira, McCrady, 1857, Gymn. Charleston Harbor, p. 88, plate 11, figs. 8, 9.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 363.—Agassiz, A., 1865, North Amer. Acalephæ, p. 116.—Haeckel, 1879, Syst. der Medusen, p. 191.—Brooks, 1884, Zool. Anzeiger, Jahrg. 7, p. 709; 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 395, plates 38, 39 (hydroid).—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 378, fig. 93.
Eutima limpida, Agassiz, A., 1865, North American Acal., p. 116, figs. 173, 178.
Eutima emarginata (young medusa), Brooks, 1882, Studies Johns Hopkins Biol. Lab., vol. 2, p. 141.
Eutima mira = E. limpida, Hargitt, 1908, Biol. Bulletin, vol. 14, p. 111.
Eutima gracilis (young medusa), Fewkes, 1881, Bull. Museum Comp. Zool. at Harvard College, vol. 8, p. 158, plate 5, figs. 1–4.

Bell about 1.5 times as broad as high, about 15 to 30 mm. in diameter. There are 4 radially situated tentacles, each about 3 times as long as bell-diameter; also about 100 small, rudimentary nodules upon the bell-margin, some of which give rise to cirri. There are usually *no lateral cirri* flanking the tentacles *when adult*, but these commonly occur in the young medusa. There are 8 lithocysts, 2 in each quadrant. Each lithocyst contains 4 to 8 spherical, highly refractive concretions. Velum quite well developed. There are 4 straight, slender radial-

Synopsis of Described Species of Eutima.

	E. mira McCrady.	E. cuculata Brooks.	E. insignis Haeckel.	E. orientalis Browne.	E. curva Browne.	E. elephas Haeckel.
Size of bell in mm.	15 to 30 wide, 6 to 12 high.	8 wide, 2 high.	8 wide, 4 high.	6 wide, 3 high.	10 wide, 6 high.	20 wide, 9 high.
Number of well-developed tentacles.	4, sometimes flanked by cirri. Often without lateral cirri.	4 with abaxial flaps above tentacle-bulbs. No lateral cirri.	4, flanked by cirri.	4, flanked by cirri.	4, flanked by cirri. Basal bulbs curve upward over bell.	4. No cirri.
Condition of marginal cirri on rudimentary tentacles.	100+. Marginal nodules or cirri.	35 to 40 marginal cirri.	28 to 30 nodules flanked by cirri.	68 to 80 nodules flanked by cirri.	120 to 140 nodules all flanked by cirri.	100± nodules. No cirri.
Length of peduncle in terms of bell-radius (*r*).	2.5. Conical, slender.	2 *r*. Conical above, prismatic below.	2 to 4 *r*. Cylindrical.	4 *r*. Dome-like above, prismatic below.	2 *r* Pyramidal above, prismatic below.	6 to 8 *r*, narrow, cylindrical.
Condition of gonads.	8. 4 on subumbrella and 4 on peduncle.	4 as in E. mira.	4 on peduncle.	8 as in E. mira.	4 on peduncle.	4 on peduncle.
Color.	Milky, blue-white, or green stomach, gonads, and tentacle-bulbs. Sometimes nearly colorless.	As in E. mira.	Colorless.		Black pigment in tentacle-bulbs.	Green or bluish-white tentacle-bulbs, gonads, and stomach.
Where found.	Atlantic coast of North America, south of Cape Cod.	Beaufort, North Carolina.	British coast.	Ceylon.	Ceylon.	North Atlantic. Helgoland to Florida.
Remarks.	Probably identical with E. limpida.	Distinguished by hood-like flaps above tentacle-bulbs.	Probably an arrested form of E. campanulata.	Is this young of E. campanulata?	Appears to be most nearly allied to E. cuculata.	Distinguished by very long peduncle.

	E. lactea Bigelow.	E. levuka Agassiz and Mayer.	E. gentiana Haeckel.	E. campanulata.	E. cœrulea.	E. pretiosa.
Size of bell in mm.	9 wide, 4.5 high.	8 wide, 3 high.	8 wide, 10 high.	30 wide, 15 high.	10 wide, 7.5 high.	40 wide, 17 high.
Number of well-developed tentacles.	8 with lateral cirri.	8 with lateral cirri.	8 with lateral cirri.	16 to 32 with lateral cirri.	32 flanked by cirri.	60 to 80 with cirri.
Condition of marginal cirri or rudimentary tentacles.	24 papillæ without cirri.	24 papillæ flanked by cirri.	64 cirri.	150± papillæ with cirri.	96 papillæ. No cirri.	Many cirri and a few papillæ.
Length of peduncle in terms of bell-radius (*r*).	2 *r*. Slender.	3 *r*. Slender.	2 *r*. 4-sided prism.	2 *r*. Slender, tapering.	*r* long. Tapering, slender.	*r* long. Tapering, wide.
Condition of gonads.	4 on peduncle.	4 near ring-canal.	4 on peduncle.	8 on peduncle and subumbrella.	4 extending over peduncle and subumbrella.	4 on both peduncle and subumbrella.
Color.	Gonads white.	Gonads, stomach, tentacles, milky. No black pigment.	Gonads and tentacles milky.	Gonads, tentacles, stomach and canals greenish.	Stomach, gonads white. Tentacle-bulbs green.	?
Where found.	Maldive Islands, Indian Ocean.	Fiji Islands, Pacific.	Canary Islands, Atlantic.	Mediterranean; Atlantic coasts of Europe. Ceylon?	Bahamas; and Tortugas, Florida.	Coast of Australia.
Remarks.	Closely allied to E. gentiana.	E. levuka var. occellata from the Malay Archipelago has black-pigmented tentacle-bulbs.	Closely allied to E. lactea.		Bell thick walled. Tentacles very short. Peduncle slender.	Peduncle very wide at base, thick, prismatic.

canals and a narrow circular vessel. The peduncle is about 3 times as long as height of bell, long, conical, and tapering gradually throughout its length from inner apex of bell-cavity to stomach. Stomach small and flask-shaped, its proximal part, near point of union with peduncle, thrown into complex folds. There are 4 simple, slightly recurved lips. The gonads are situated upon the radial tubes, in two separate regions, one upon the peduncle, and one upon the subumbrella.

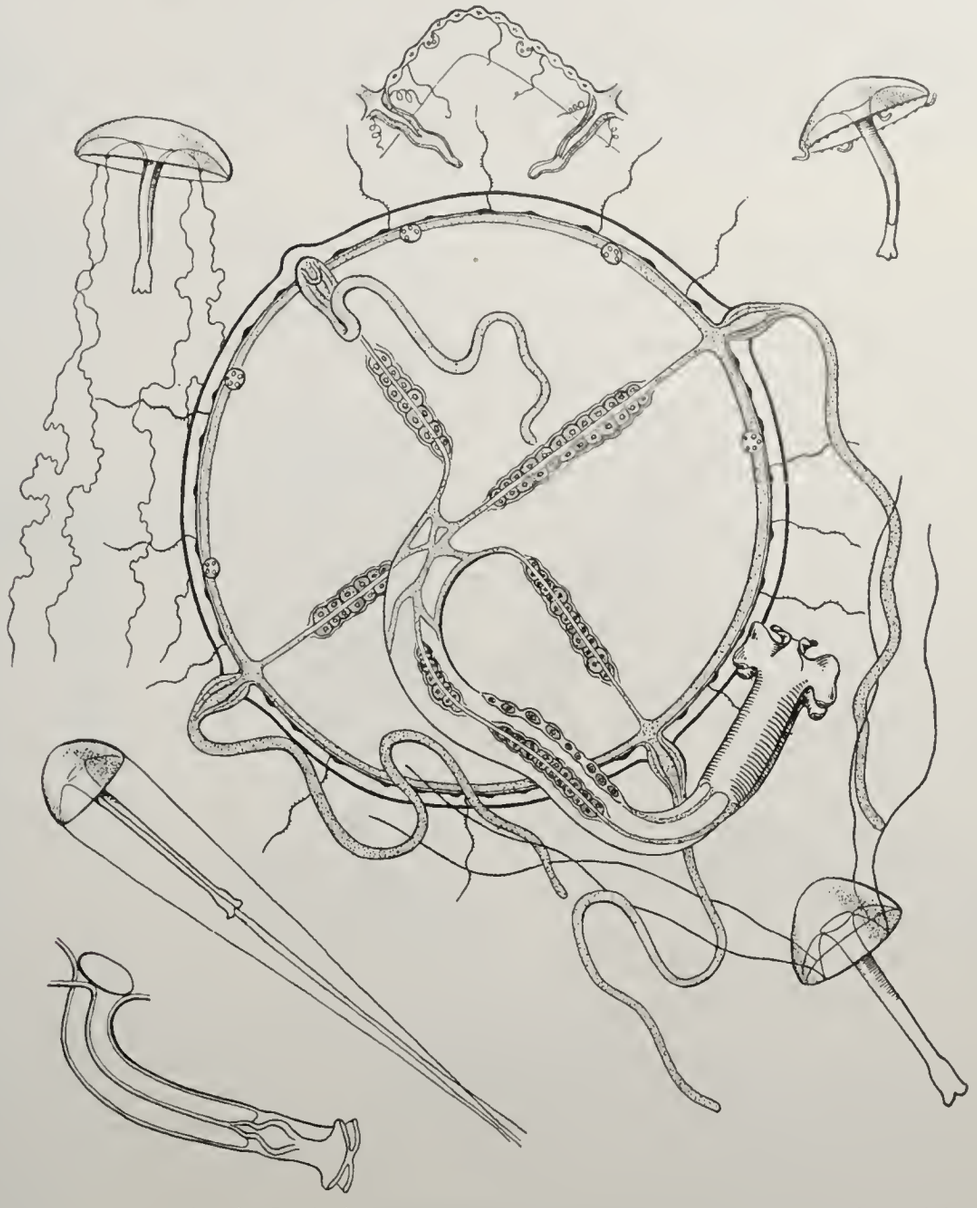


FIG. 160.—*Eutima mira*, after Brooks, in Mem. Boston Soc. Nat. Hist., 1886. Small figures are of natural size and illustrate attitudes of the medusa.

The stomach, gonads, and tentacles, opaque blue-white in color. Many specimens display green entodermal pigment in the stomach and in the basal bulbs of the 4 long tentacles.

The medusa is common at the Tortugas, Florida; Charleston, South Carolina; and Beaufort, North Carolina. It is an occasional visitant to Newport, Rhode Island, and to Woods Hole, Massachusetts, late in summer, being abundant in some years and rare in others. I am in accord with Hargitt in believing that *E. mira* is identical with *E. limpida*.

The development of *Eutima mira* has been studied by Brooks, 1884 and 1886, who reared the hydroid from the egg. The gastrula is formed by delamination of the entoderm from the inner ends of the ectoderm cells. This takes place most rapidly at the narrow end

of the pear-shaped planula. This narrow end afterwards becomes invaginated; the invaginated cells are, however, ectodermal, and have nothing to do with the gastrula cavity, but they form the cement gland which soon serves to attach the larva. One lip of this orifice of invagination grows faster than the other, so that the cavity is soon pushed to one side and the larva becomes bilateral. When the larva attaches itself this invaginated ectoderm is protruded and pours out its cement. The planula then elongates and forms a layer of perisarc which fastens it throughout its entire length. It thus becomes a hydrorhiza, not a hydranth. The first hydranth buds out at right angles to the length of the hydrorhiza at the end opposite to the cement gland. As soon as the first hydranth has acquired mouth and tentacles another buds out close to the base of the first and so on. The planula, therefore, persists as a root (hydrorhiza) and produces the hydranths by budding.

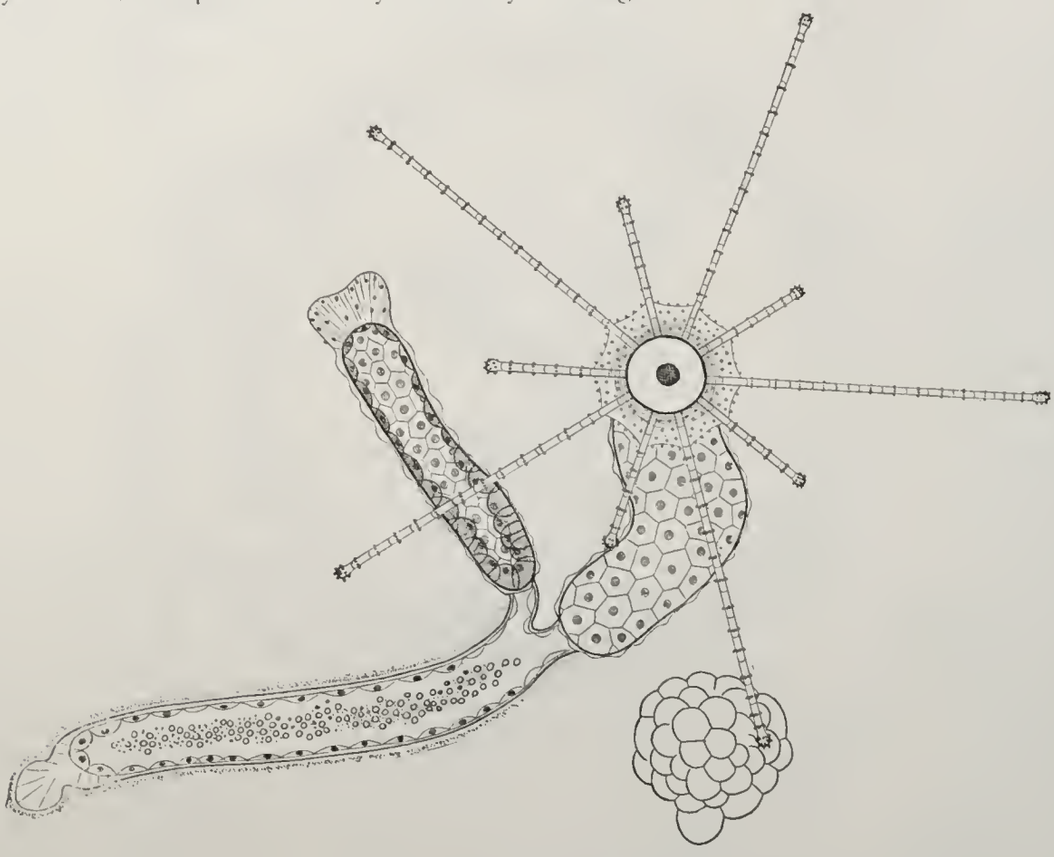


FIG. 161.—Larva of *Eutima mira*, after Brooks, in Mem. Boston Soc. Nat. Hist., vol. 3.

The young hydranth has a tentacular basal web and 5 large alternating with 5 smaller tentacles; 10 in all. The body of the hydranth is elongated and cylindrical, and is not covered by the perisarc which invests the unannulated stem. The hydroid is a *Campanopsis*, very similar to that from which Claus, 1881, reared *Eutima (Octorchis) gegenbauri*.

Eutima cuculata Brooks.

Eutima cuculata, BROOKS, 1883, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 140.

Bell about 8 mm. in diameter and quite flat, being about 4 times as wide as high. The gelatinous substance is quite thick in the center, so that the cavity of the bell is very shallow and forms less than half of the total height of the bell. The gelatinous substance diminishes gradually in thickness from the center of the margin, where it forms a thin edge. 4 slender tentacles, which are 3 or 4 times as long as bell-diameter. The basal bulbs of these tentacles are small and there are no lateral cirri. Above the base of each tentacle is a small semicircular flap or hood, which is formed from the gelatinous substance of the bell. There are 9 or 10 very small marginal cirri in each quadrant. There are 8 lithocysts, 2 in each quadrant.

Each lithocyst contains 3 to 8 spherical concretions. There are 4 slender radial-tubes. The peduncle is about as long as the bell diameter. It is conical above and prismatic below. Stomach about one-fourth as long as peduncle, with 4 simple lips. There are 4 gonads upon the 4 radial-canals, one on each canal. They extend from near the bell-margin to base of peduncle, but do not run down along the prismatic part of the peduncle.

The stomach and the entoderm of the tentacle-bulbs are intense green by reflected light.

This species was found by Professor Brooks at Beaufort, North Carolina, on August 7, 1880.

The bell is flatter than in *Eutima mira* McCrady, the tentacles are longer, and the marginal cirri less numerous, but the only really distinctive feature appears to be the semi-circular flaps above each tentacle-bulb.

Eutima insignis Haeckel.

Siphonorhynchus insignis, Keferstein, 1862, Zeit. für wissen. Zool., Bd. 12, fign. 3-8.
Eutima insignis, Haeckel, 1879, Syst. der Medusen, p. 192.—Browne, 1895, Proc. and Trans. Liverpool Biol. Soc., vol. 9, p. 282; 1896, Proc. Zool. Soc. London, p. 492.

Bell 8 mm. wide, hemispherical. 4 radially placed tentacles 2 or 3 times as long as the bell-diameter, each flanked by a pair of basal cirri; also about 30 tentacle-bulbs, each flanked by a pair of cirri. There are 8 adradial lithocysts each with 2 to 5 concretions. Peduncle long, narrow, and of uniform width, being 1 or 2 times as long as the bell-diameter. The stomach is about half as long as the bell-radius, flask-shaped, with 4 large lips. The 4 gonads flank the 4 radial-canals on the peduncle. They begin to develop near the stomach and extend upward. The medusa is colorless.

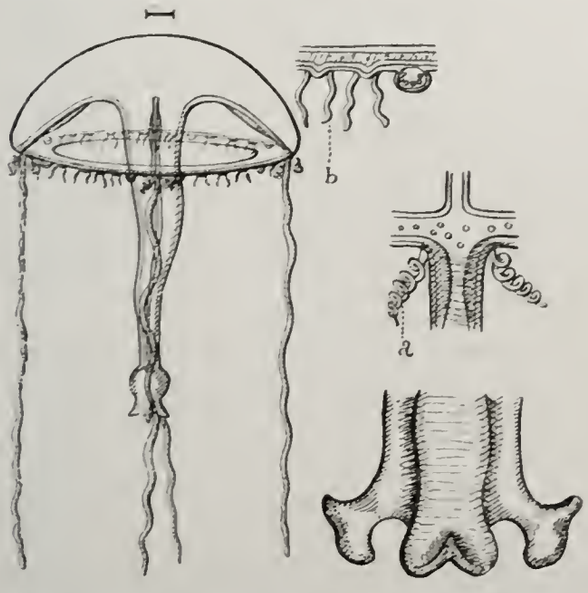


Fig. 162.—*Eutima "gracilis,"* after Fewkes, in Bull. Museum Comp. Zool. at Harvard College. *a*. Lateral cirri. *b*. Marginal cirri.= Young of *E. mira*.

Found at St. Vaast, northwest coast of France; off the British coasts, Plymouth, Isle of Man. Hydroid unknown.

Browne, 1898 (Journal Marine Biol. Assoc. Plymouth, n. s., vol. 5, p. 190), believes that *Saphenia mirabilis* is probably a 2-tentacled, young stage or an arrested form of *Eutima insignis*, which becomes mature with but 2 tentacles. It may, on the other hand, be an arrested form, or starved variety, of *E. campanulata*.

Eutima orientalis.

Octorchis orientalis, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 139, plate 3, fig. 4.

Bell probably hemispherical, 5 or 6 mm. wide. 4 long radial tentacles, with elongate cylindrical basal bulbs. 18 to 20 marginal bulbs on each quadrant of the margin, each bulb with a lateral cirrus. 8 lithocysts near the 4 tentacles. Concretions (?) 4 straight, narrow radial-canals. Peduncle about twice as long as bell-diameter, with a dome-like base and elongate 4-sided, prismatic, central part. Stomach small, with 4 short lips with sinuously folded margins. 8 gonads, 2 on each radial-canal. They are well developed over the middle two-thirds of the subumbrella lengths of the 4 radial-canals. Galle Bay, Ceylon, June to August. Closely related to *E. campanulata*, but distinguished by having only 4 tentacles instead of 8. *E. campanulata*, however, is often found with but 4 tentacles and immature gonads. When mature it appears to have 8 or more tentacles. *E. orientalis* is probably only a variety of *E. campanulata* which becomes mature (?) when it has 4 tentacles. Browne studied 10 specimens.

Eutima curva Browne.

Eutima curva, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, p. 138, plate 3, figs. 1–3.

Bell 10 mm. wide, 6 mm. high, walls quite thick. 4 radially placed tentacles with long, tapering, cone-shaped, laterally compressed, basal bulbs, which curve upward over margin of umbrella. 30 to 35 marginal bulbs on each quadrant of the margin, with usually one, occasionally 2, coiled cirri alongside each bulb. 8 adradial lithocysts, each with 8 to 10 concretions arranged in a semicircle. 4 narrow radial-canals. Peduncle as long as bell-diameter, 4-sided, pyramidal above, prismatic below. Stomach small, about twice as long as wide, with 4 small lips with sinuous margins. 4 gonads along nearly the entire length of the prismatic lower part of the peduncle over the 4 radial-canals. Mature (?) Tentacle-bulbs have blackish pigment at their apices. Found off Mutwal Island, west coast of Ceylon in March. Only one specimen observed.

Eutima elephas.

Plate 40, figs. 1 to 1″.

Eutimium elephas, Haeckel, 1879, Syst. der Medusen, p. 190, taf. 12, fign. 10–12.
Eutimium serpentinum, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 58, plate 23, figs. 69–72.

Bell 16 to 20 mm. wide, with flaring sides, conically rounded apex and thick gelatinous walls. 4 radially placed, filamentous tentacles, each about 1.5 times as long as bell-diameter. 8 large lithocysts, 2 in each quadrant, each with about 8 to 10 concretions arranged in a crescentic line within cavity of concretion. No marginal cirri, but numerous minute, wart-like thickenings upon bell-margin. Velum well developed. Peduncle 3 or 4 times as long as bell-diameter. Upper end of peduncle conical, then follows a long, narrow, 4-sided, prismatic part which bears the short, urn-shaped, 4-sided stomach. There are 4 recurved, slightly folded lips. The 4 narrow radial-canals extend straight from the marginal canal down the angles of the peduncle to the corners of the stomach. The gonads are found upon the narrow, elongate, prismatic part of the peduncle, where they lie on both sides of each of the radial-canals.

Stomach light-greenish. The margins of lips, angles of stomach, canal system, and tentacles are beautiful verdigris or emerald green. (See text-figure 163.)

Haeckel found this medusa at Helgoland, German Ocean, in 1854. An apparently identical medusa appears each year in surface-tows at Tortugas, Florida, in July. The only difference between the Tortugas medusa and that of Haeckel is that the Tortugas form is dull opaque, bluish-white, or dull-green in color, and I have never observed the brilliant coloration described in the Helgoland form. While one may reasonably hesitate to group under one specific name creatures so remotely separated geographically, yet the difference between the two forms appears so slight as to incline one to regard it at most as of varietal rather than specific value, especially as green and milky-white are alternate colors in other species of *Eutima*, such as *E. mira*. The presence of marginal warts upon the bell-rim is a character which obliges us to place this medusa in the genus *Eutima*. It is distinguished by its very long, narrow, cylindrical peduncle. Hydroid is unknown.

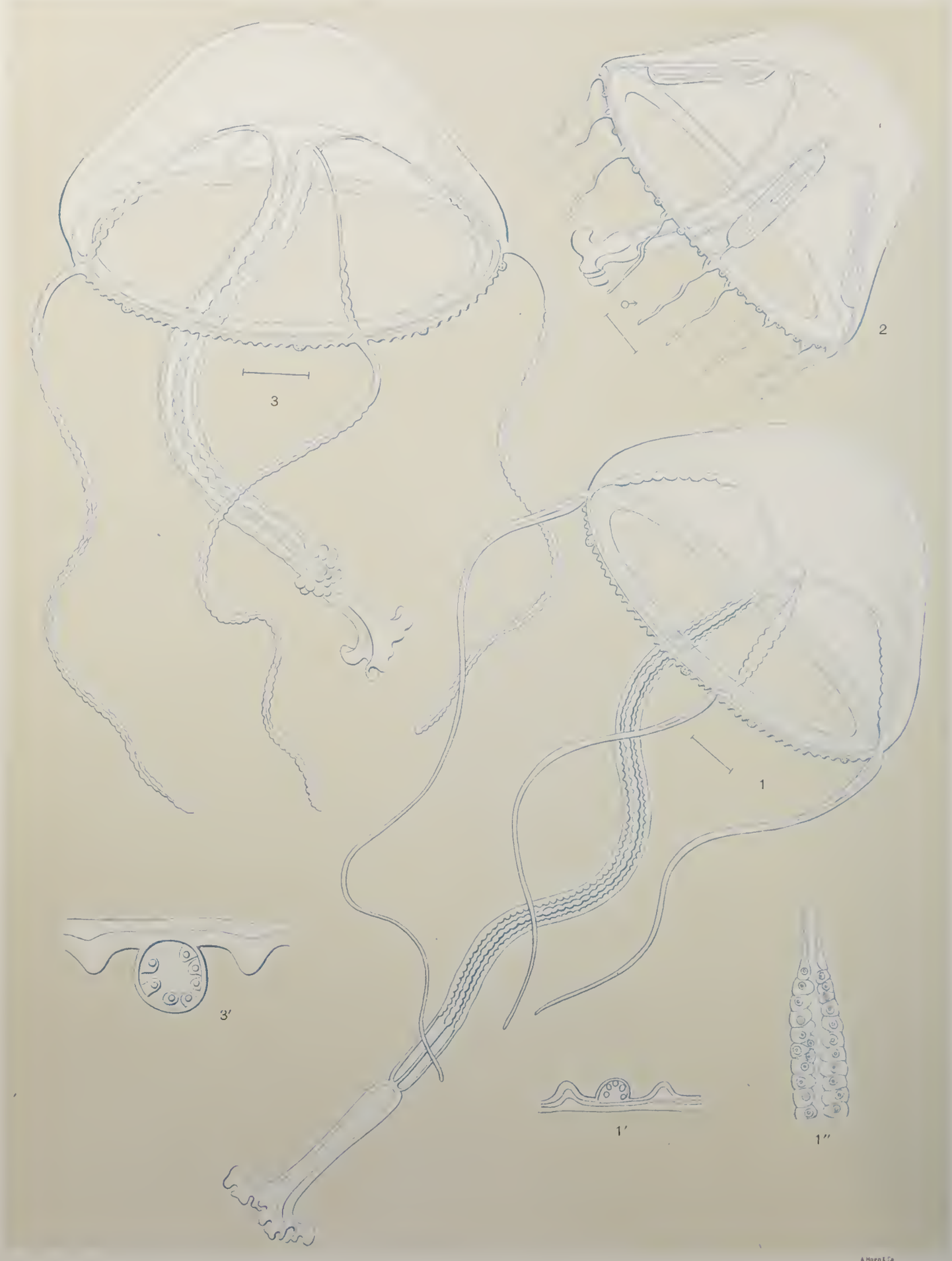
Eutima lactea.

Eutimeta lactea, Bigelow, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 253, plate 2, figs. 7, 8.

Bell thin, rounded to conical, 9 mm. wide, 4.5 mm. high. 8 tentacles, the 4 radial ones being about as long as bell-diameter, the 4 interradial ones shorter. Tentacle bases have lateral spurs. Also about 24 small papillæ on bell-margin, none having lateral cirri. 8 lithocysts, each with 4 or 5 concretions. Peduncle slender and almost as long as the bell-diameter. Stomach cylindrical, two-thirds as long as bell-height. Mouth with 4 slightly foliated lips. The 4 large, swollen gonads occupy the middle two-thirds of the radial-canals on the peduncle.

Bell nearly colorless. Tentacles and manubrium are of a bluish tinge and the gonads are opaque, milky white. Maldive Islands, Indian Ocean; December.

This species is most closely related to *E. gentiana* Haeckel, from the Canary Islands, but has smaller marginal cirri and a bell differing in shape. It differs from *E. levuka* of Fiji in the position of its gonads, for in *E. levuka* these are on the 4 radial-canals near the ring-canal, while in *E. lactea* they are confined to the peduncle. (See text-figure 164.)



A Hoen & Co

PLATE 40.

Figs. 1 to 1″. *Eutima elephas*, mature female medusa. Figure 1′, marginal lithocyst; figure 1″, part of one of the gonads on the peduncle. Tortugas, Florida, May 31, 1906.

Fig. 2. *Phortis lactea*, male medusa. Tortugas, Florida, May 28, 1905. Drawing not colored.

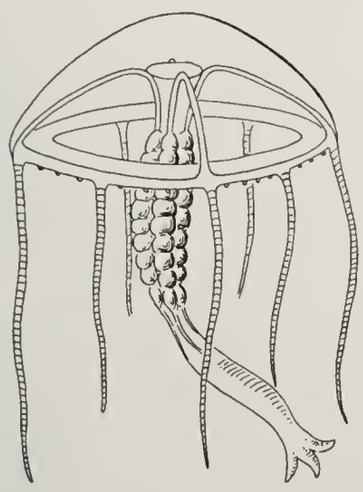
Figs. 3 to 3′. *Eutima mira*. Figure 3′, lithocyst. Tortugas, Florida, June 10, 1897.

Drawn from life, by the author.

Eutima levuka.

Eutimeta levuka, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 163, plate 9, figs. 30, 31.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 165, plates 5 and 35.

Bell thin, flatter than a hemisphere, 8 mm. in diameter. 8 well-developed hollow tentacles, 4 about as long as diameter of bell, 4 others only about half this length. Small lateral cirri are found upon the sides of these tentacles. Besides the large tentacles described, there are 24 small papillæ upon the bell-margin, flanked by lateral cirri exactly as are the large



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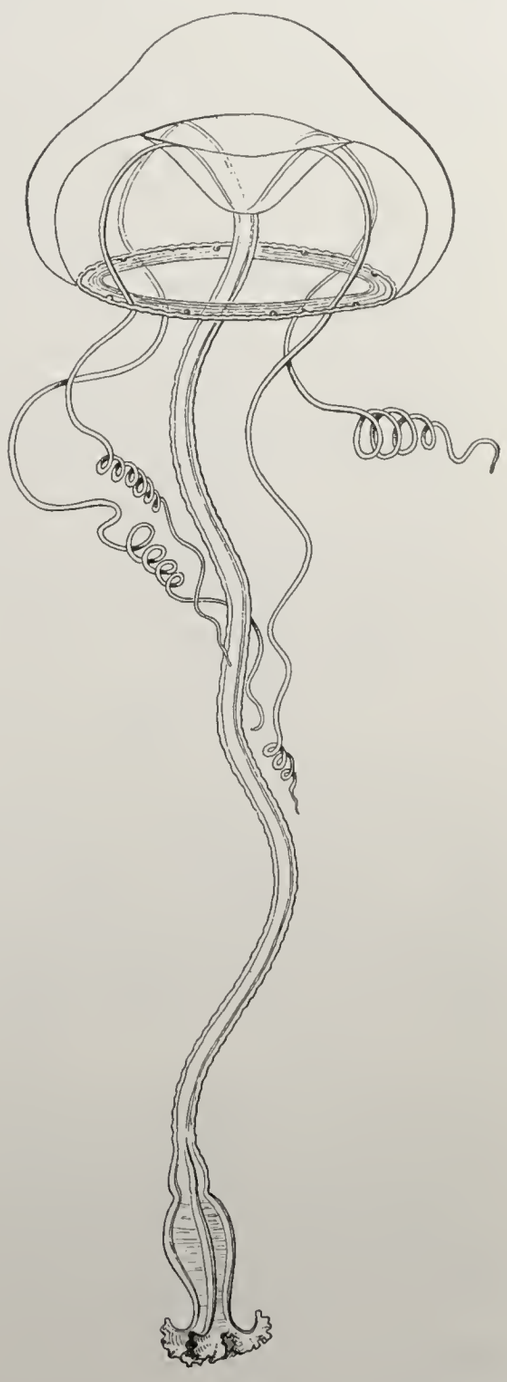

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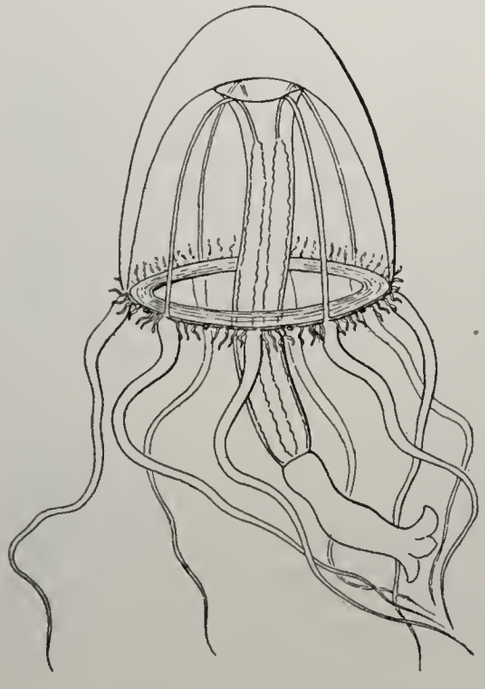

165.

Fig. 163.—*Eutima elephas*, after Haeckel, 1879.
Fig. 164.—*Eutima lactea*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.
Fig. 165.—*Eutima gentiana*, after Haeckel, 1879.

tentacles. There are 8 lithocysts, each one of which contains 3 to 5 concretions. Velum large. The 4 radial-canals are straight and narrow, and the gonads are found upon them near to the circular vessel. Peduncle is slender and 1.5 as long as diameter of bell. Stomach flask-shaped, 4 flanged lips. The genital organs, tentacles, and stomach slightly opaque and bluish in color. Several specimens, Suva Harbor, Fiji Islands, January, 1898. Bigelow found it in Acapulco Harbor, Pacific coast of Mexico.

Eutima levuka var. occellata, Maas.

Eutima levuka var. *occellata*, Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 35, taf. 7, fign. 43, 44.

This variety is distinguished from *E. levuka* from the Fiji Islands by having black-pigmented, rudimentary tentacle-bulbs on the margin, while in *E. levuka* from Fiji the rudimentary tentacle-bulbs are colorless. The bell in large specimens of *E. levuka* var. *occellata*, is 12 to 15 mm. wide, flatter than a hemisphere, with fairly thin walls. There are typically 8 long, hollow tentacles, 4 radial, 4 interradial. These are about as long as the bell-diameter and have flattened, elongate basal bulbs. 16 to 20 small rudimentary tentacle-bulbs on the margin in each quadrant, more or less pigmented with black, each flanked by a pair of short cirri. There are 8 lithocysts, 2 in each quadrant.

The peduncle is narrow, 4-sided, and pyramidal above. It is about 1.5 times as long as bell-diameter. Stomach small, urn-shaped, 4-sided, with 4 slightly folded lips. The 4 radial-canals extend from the ring-canal down the 4 angular corners of the peduncle to the stomach.

In young specimens we find gonads only on the subumbrella parts of the 4 radial-canals, but in large medusæ they are found not only on the distal part of each radial-canal over the subumbrella but also throughout almost the entire length of the prismatic part of the peduncle. The gonads upon the subumbrella are spindle-shaped, with their pointed ends near inner apex of bell-cavity, their blunt ends near the ring-canal.

Maas gives a good description and clear figures of this form. It was found in considerable numbers by the *Siboga* Expedition upon the surface of the sea among the Malay Islands, Ternate, Salomakië, Lucipara, etc. Bigelow finds that it intergrades with *E. levuka* and is not a well-defined variety.

Eutima gentiana Haeckel.

Eutimeta, Eutima, Geryonopsis gentiana, Haeckel, 1879, Syst. der Medusen, p. 194, taf. 12, fign. 6–9.

Bell half-egg-shaped, with fairly thin walls, 8 mm. wide, 10 mm. high. 8 long tentacles with conical bases, flanked by cirri. 64 marginal cirri. 8 lithocysts end with 3 to 4 concretions. Stomach elongate, urn-shaped, about as long as the bell-radius, and mounted upon a peduncle which is narrow, uniform, 4-sided, prismatic, and about as long as the bell-diameter. 4 gonads on the 4 radial-canals of the peduncle above the stomach. The gonads and tentacles are whitish. Found by Haeckel at the Canary Islands. Hydroid unknown. When young the medusa has 4 radially placed tentacles, 8 lithocysts, no cirri, and no peduncle. Then the peduncle develops, interradial tentacles grow out, and cirri make their appearance.

Eutima campanulata.

Liriopsis campanulata, Claus, 1876, Verhandl. Zool. Bot. Gesell. Wien, Bd. 26, p. 11.
Octorchidium tetranema (young medusa without cirri), Haeckel, 1879, Syst. der Medusen, p. 196, taf. 13, fig. 9.
Octorchis gegenbauri + *O. campanulatus*, Haeckel, 1879, Syst. der Medusen, p. 197, taf. 13, figs. 2, 10–16; *Ibid.*, p. 198, taf. 13, fign. 3–8, *Octorchandra germanica; Ibid.*, plate 13, fig. 1, *Octorchandra canariensis.*
Octorchis gegenbauri, Claus, 1881, Arbeit. Zool. Inst. Wien, Bd. 4, p. 89, taf. 1, fign. 1–10; taf. 2, fign. 10–20 (hydroid [*Campanopsis*] and medusa).—Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 358.—Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, p. 23 (egg), p. 42 (segmentation), p. 52 (formation of entoderm), p. 79 (polypite), taf. 3, fign. 10–19.—Browne, 1896, Proc. Zool. Soc. London, p. 494; 1905, Proc. Royal Soc. Edinburgh, vol. 25, p. 771.
(?) *Octorchis gegenbauri*, Browne, 1905, Pearl Oyster Fisheries, Gulf of Manaar, p. 140 (medusa from Gulf of Manaar, Ceylon).

Haeckel, 1897, appears to me to have made 5 species and 3 genera from this medusa as follows:

Octorchidium tetranema, bell 3 mm. wide, 4 tentacles, no cirri.
Octorchis gegenbauri, *O. campanulata*, 8 or 9 mm. wide, 8 tentacles, 40 to 300 cirri.
Octorchandra germanica, 15 mm. wide, 12 to 16 tentacles, 30 to 50 cirri.
Octorchandra canariensis, 25 to 30 mm. wide, 16 to 32 tentacles, 200 to 300 cirri.

Claus, 1881, who has made a most elaborate study of *O.* "*gegenbauri*," states that it is identical with Haeckel's *O.* "*germanica*," and it seems probable that Haeckel has constructed the above genera and species out of growth-stages in the development of one and the same medusa; also that the medusa may become mature with 8 or only after it has acquired 16 or more tentacles, such phenomena being not uncommonly observed among Hydromedusæ. The following is a description of the latest stage="*Octorchandra canariensis*" Haeckel: Bell hemispherical, 25 to 30 mm. wide. There are 16 to 32 tentacles somewhat longer than the bell-diameter. 120 to 150 tubercles upon the bell-margin with 200 to 300 helically coiled cirri between them. 8 adradial lithocysts, each with a crescentic row of 16 to 20 concretions. Velum well developed. Peduncle tapering, narrow, and nearly prismatic below, but flaring outward above where it arises from the subumbrella. Peduncle about as long as the bell-

166. 167.

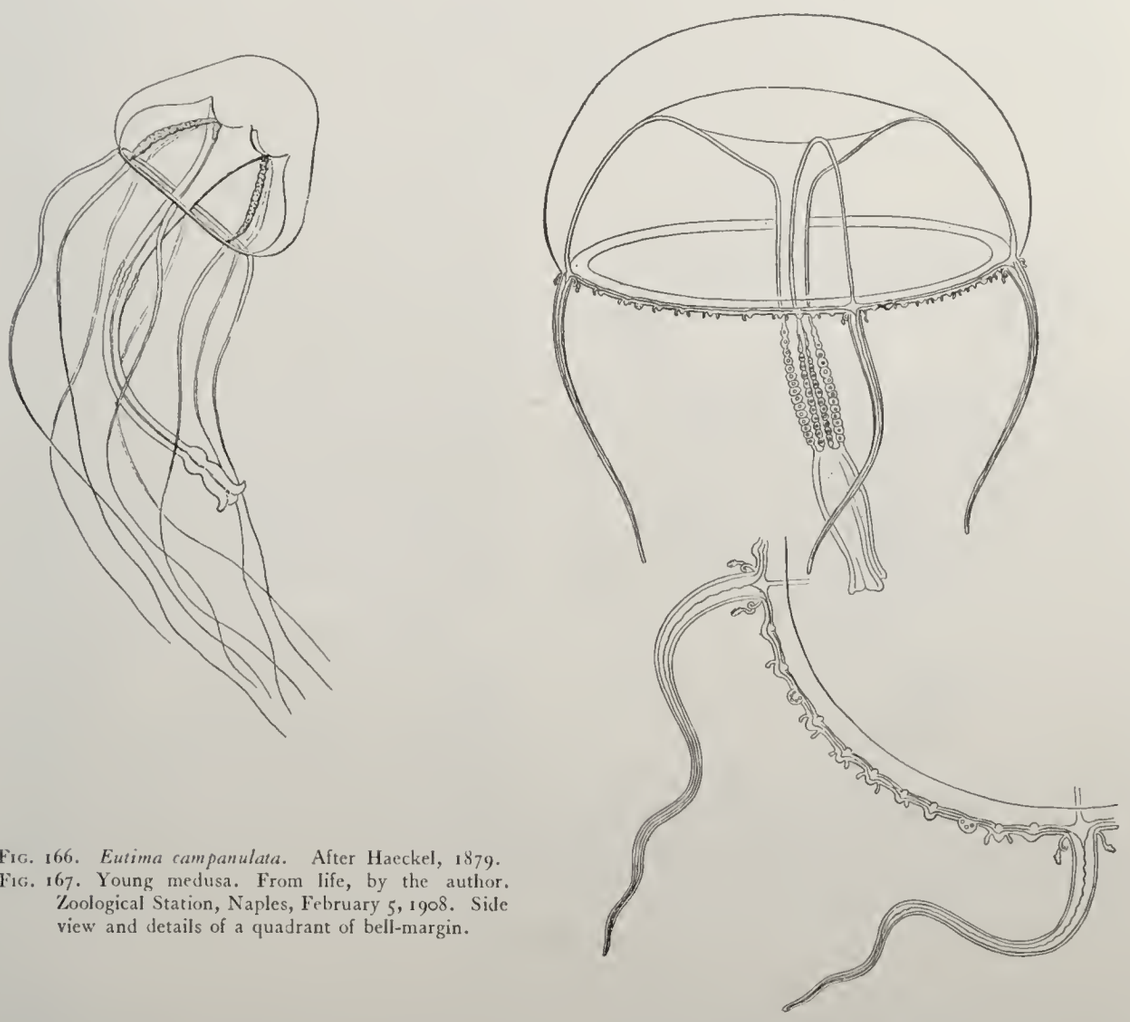

Fig. 166. *Eutima campanulata.* After Haeckel, 1879.
Fig. 167. Young medusa. From life, by the author. Zoological Station, Naples, February 5, 1908. Side view and details of a quadrant of bell-margin.

diameter. Stomach urn-shaped, 4-sided, short, with 4 recurved lips having folded margins. The linear gonads are found upon the subumbrella regions of the 4 narrow radial-canals and also upon the peduncle about half-way between the stomach and the base of the peduncle. Thus there are 2 gonads on each of the 4 radial-canals. The 4 gonads on the subumbrella are fully twice as long as those on the peduncle. Stomach, canal-system, gonads, and tentacles more or less greenish, sometimes verdigris-green or emerald-green.

This form is described by Haeckel from the Canary Islands. Medusæ similar to the above, but with 8 to 16 tentacles, are found quite commonly in surface-tows in the Mediterranean and off the Atlantic coasts of France, Great Britain, and Germany. According to Graeffe, 1884, the medusæ are set free from the hydroids at Trieste, Adriatic, in April and May, and become mature in May and June, and still another brood of young medusæ

appears in winter. Graeffe identifies Haeckel's *O. gegenbauri* with *Liriopsis campanula* of Claus, 1876.

Browne, 1905, finds a medusa which appears to be identical with this species in the Gulf of Manaar between Ceylon and India.

The development of the Mediterranean medusa has been studied by Metschnikoff, 1886, and Claus, 1881. Metschnikoff finds that the egg is 0.14 mm. wide and is laid at 8 in the evening in December. The segmentation is total, but not quite equal, and a hen's-egg-shaped one-layered blastula is formed. The entoderm is formed from cells which migrate inward into the central space from the narrow, hinder end of the larva. The planula becomes ciliated, attaches itself by its forward end, and then the hinder end grows upward into a hydroid of the genus *Campanopsis*.

Claus was the first to discover the hydroid (*Campanopsis*), which he reared from the egg in an aquarium. The hydrorhiza is creeping, open, and branched, and is found attached to mussels or stones. The polypites are elongate, spindle-shaped, and arise singly at intervals from the hydrorhiza. The mouth is at the extremity of a short, conical hypostome. There is a single circlet of about 24 long, filiform, tapering, oral tentacles, which are united at their bases by a web. These tentacles bear prominent nematocysts. The medusæ bud out singly from the sides of the polypite below the zone of oral tentacles. Several medusa-buds are seen at one and the same time upon the sides of each polypite. They are invested only by a thin perisarc and are not produced within horny capsules as in other Campanularian hydroids. Indeed this interesting hydroid appears intermediate in its characters between Campanularian and Tubularian hydroids, although it is probably merely a highly specialized and modified Campanularian which has lost its hydrothecæ and gonangial capsules.

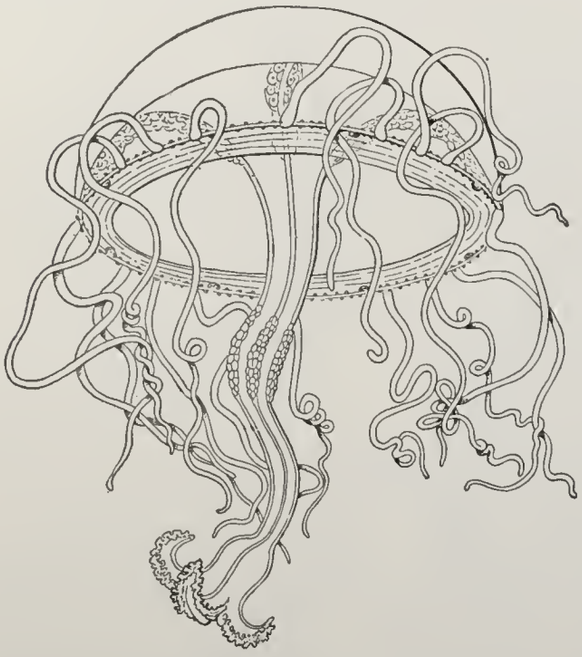

Fig. 168.—"*Octorchandra canariensis*," after Haeckel, in Das System der Medusen = *Eutima campanulata*.

When set free the young medusa is about 1 mm. wide, with a thin-walled bell, higher than a hemisphere. There are 4 simple, straight radial-canals without gonads, 2 well-developed, radially placed tentacles, and 2 short tentacles 90° apart from the long ones. Each of the 4 tentacle-bulbs bears a lateral cirrus, and in addition to these there are 4 small interradial cirri. No peduncle. Stomach a mere short cylindrical tube.

Eutima cœrulea.

Plate 41, figs. 4 and 5.

Eirene cœrulea, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 362.—Agassiz, A., 1865, North American Acal., p. 112, fig. 163.
Irene cœrulea, Haeckel, 1879, Syst. der Medusen, p. 203.
Eutimalphes cœrulea, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 57, plate 11, figs. 22, 22*a*.

Bell is 10 mm. in diameter, a little broader than it is high. The gelatinous substance at the apex of the bell is quite thick, but becomes progressively thinner as one approaches the margin. There are about 32 short, slender, marginal tentacles, each flanked with a pair of small lateral cirri; also about 96 rudimentary tentacular swellings upon the bell-margin there being usually about 3 of these swellings between each successive pair of tentacles. There are 8 lithocysts, 2 in each quadrant, and each one of them contains 3 to 5 spherical concretions. 4 radial-tubes. Velum well developed. 4 linear, slightly convoluted gonads. They begin about half-way between the circular vessel and the peduncle and extend to a point

Plate 41.

Fig. 1. *Tima formosa*, natural size. Newport, Rhode Island, April 20, 1897. (See page 317.)

Fig. 2. *Tima formosa*. Part of the bell-margin.

Fig. 3. *Tima formosa*. One of the marginal lithocysts.

Figs. 4 and 5. *Eutima cærulea*. Figure 5′, part of the bell-margin. Key West, Florida, May, 1897.

Fig. 6. *Phortis lactea*, mature female. Tortugas, Florida, June, 1898. (See page 308.)

Drawn from life, by the author.

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close to the stomach. Peduncle well developed, narrow, tapering, and reaching slightly beyond the velar opening, being about as long as bell-radius. Stomach short, 4 slightly fimbriated lips. The stomach and gonads are opaque white, the tentacle-bulbs green. Common at the Bahamas and Tortugas in spring and winter months. Hydroid unknown.

Eutima pretiosa.

Eutimalphes pretiosa, Haeckel, 1879, Syst. der Medusen, p. 195, taf. 11, fig. 8.

Bell flatter than a hemisphere, 40 mm. wide. 60 to 80 short, crumpled tentacles, with thick, conical basal bulbs. Numerous cirri; a few marginal warts are scattered between the tentacles. 8 large lithocysts, each with 16 to 20 concretions. Peduncle thick and pyramidal, about as wide as the bell-radius at its base and as long as wide. Stomach large, with 4 very large, recurved lips with curtain-like, complexly folded margins. Each lip is about as long as bell-radius. 4 linear, folded, curtain-like gonads occupying nearly the entire lengths of the 4 radial-canals. Described by Haeckel from a preserved specimen found off the coast of Australia. (See text-figure 169.)

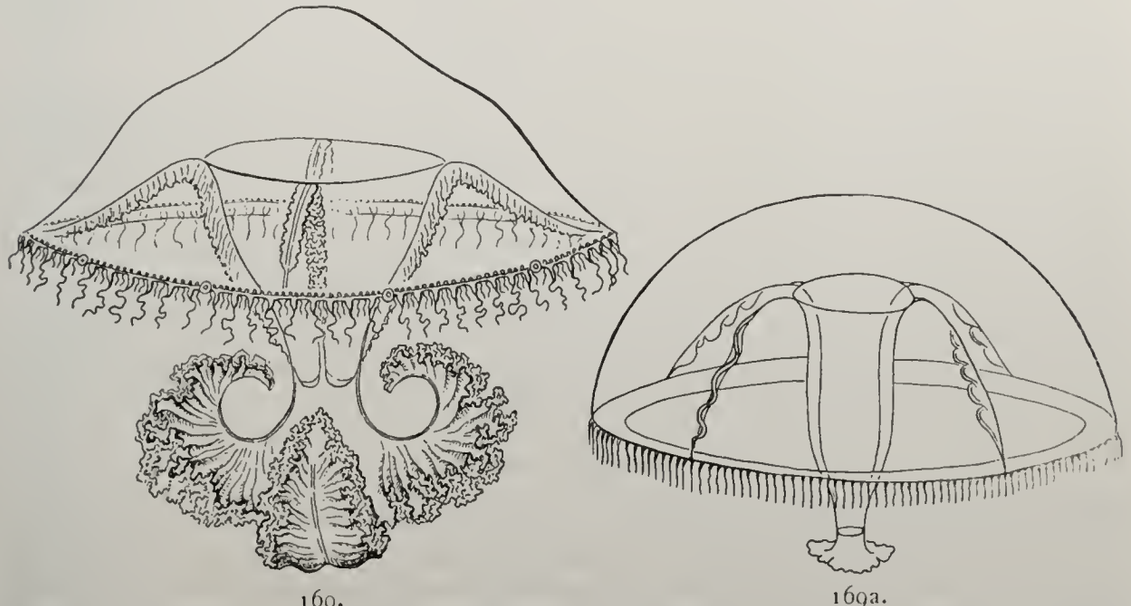
Genus EUTIMIUM Haeckel, 1879, sens. ampl.

Eutimium+Octorchidium, Haeckel, 1879, Syst. der Medusen, pp. 190. 195.
Eutimium, Hartlaub, 1894, Meeresfauna von Helgoland, p. 194.
Eutonina, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommiss. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 506.

The genus *Eutimium* was founded by Haeckel, 1879, for *E. elephas* of the German Ocean, but this has marginal warts and should be called *Eutima*.

GENERIC CHARACTERS.

Eucopidæ with 8 lithocysts, 2 in each quadrant, and with 4 or more tentacles. There are neither *cirri* nor *warts* upon the bell-margin or upon the sides of the tentacles. The gonads are developed upon the 4 radial-canals. There is a well-developed peduncle. In some species there are 8 gonads, 2 upon each radial-canal; in others, however, there are but 4 gonads, one upon each radial-canal.



169. 169a.

Fig. 169.—*Eutima pretiosa*, after Haeckel, 1879.
Fig. 169a.—*Eutimium socialis*, after M'Intosh, in Seventh Annual Report Fishery Board of Scotland.

Haeckel, 1879, restricts *Eutimium* to include only those forms with 4 tentacles which have 4 gonads, one on each radial-canal. He applies the generic name *Octorchidium* to embrace those forms which have 8 gonads, 2 on each radial-canal.

Eutimium is very closely allied to *Eutima*, but lacks the warts or cirri which characterize the latter genus.

In 1897, Hartlaub founded the genus *Eutonina* to include Eucopidæ with 8 adradial lithocysts, *numerous* tentacles, and neither marginal nor lateral cirri. 4 gonads on the 4 radial-canals. Stomach mounted upon a peduncle. This falls clearly under the amplified genus *Eutimium* as defined above.

Eutimium bears the same relation to *Eutima* as *Phortis* does to *Eirene*, as is shown in the following table:

Characteristics.	With 8 lithocysts.	With more than 8 lithocysts.
Without cirri or marginal warts.	Eutimium.	Phortis.
With cirri or marginal warts.	Eutima.	Eirene.

Haeckel's *Octorchidium tetranema* (Syst. der Medusen, p. 196, taf. 13, fig. 9) is apparently a young *Eutima* which has not yet developed marginal or lateral cirri.

Eutimium socialis.

(?) *Tiaropsis indicans*, Romanes, 1876, Journ. Linnean Soc. of London, vol. 12, p. 525; *Ibid.*, 1877, vol. 13, plate 15, fig. 1.
(?) *Eutimalphes indicans*, Haeckel, 1879, Syst. der Medusen, p. 195.
Thaumantias ———, M'Intosh, 1889, Seventh Annual Report Fishery Board of Scotland, p. 282, plate 5, figs. 6–9.
Eutimalphes indicans, Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 194.
Eutonina socialis, Hartlaub, 1897, Wissen. Meeresuntersuch. Kommiss. Meere Kiel, Helgoland, Neue Folge, Bd. 2, p. 506, taf. 22, fign. 1, 3, 4, 6, 7; taf. 20, fign. 19, 20.

Bell flatter than a hemisphere, 30 mm. wide. Bell-walls thick above, but thin at margin. About 150 short tentacles, no cirri. 8 adradial lithocysts, each with about 12 concretions. No ocelli. Velum small. 4 slender radial-canals and a narrow ring-canal. A large spindle-shaped peduncle extends to level of velar opening. Stomach small, with 4 complexly folded lips. 4 linear, sinusoidally reflected gonads upon the subumbrella parts of the 4 radial-canals, extending not quite to the ring-canal. Stomach, gonads, and tentacle-bulbs are light sepia, other parts colorless. Hartlaub states that the hydroid is a *Campanulina*. Found at Helgoland, German Ocean, and off the east coast of Scotland from March to July.

Romanes, 1885 (International Scientific Series, vol. 49, pp. 104, 105), demonstrated that the ocelli of *Eutimium* are sensitive to light rays of the visible spectrum, but not to the ultra-violet or to the heat rays. When a beam of light falls suddenly upon a specimen of *Eutimium* the medusa remains unresponsive for about 1 second and then it contracts violently. In "*Tiaropsis** *indicans*" Romanes showed that the manubrium bends toward any place on the subumbrella which may be stimulated and applies its mouth to the stimulated spot. If, however, we make a short circumferential cut between the stimulated spot and the base of the manubrium, the manubrium merely executes wandering movements, applying its mouth to many places "as if in search of the point from which the stimulus proceeds." Hence the stimulus must proceed radially inward in a straight line from the stimulated spot to the manubrium in order that it may bend toward the stimulated place with accuracy.

Eutimium scintillans.

Eutimalphes scintillans, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 167, plates 5 and 37.

Bell 10 mm. wide, 5 mm. high. Peduncle short, only 4 mm. long. 29 to 36 tentacles, having neither knobs nor cirri. 8 large lithocysts, each with 2 to 5 concretions. 4 gonads confined to outer third of radial-canals on subumbrella. Gonads pale green. Acapulco Harbor, Pacific coast of Mexico. Common.

Subfamily EIRENINÆ.

Eucopidæ with more than 8 lithocysts. Stomach mounted upon a gelatinous peduncle. Tentacles arise from the bell-margin.

*This medusa belongs to the genus *Eutimium* and is apparently *E. socialis*.

Genus PHORTIS McCrady, 1857.

Phortis, McCrady, 1857, Gymn. Charleston Harbor, p. 90.—Brooks, 1883, Studies Johns Hopkins Univ. Biol. Lab., vol. 2, p. 470 (hyd oid and medusa).

This genus was founded by McCrady, 1857, for *Phortis gibbosa* of the southern Atlantic coast of the United States.

GENERIC CHARACTERS.

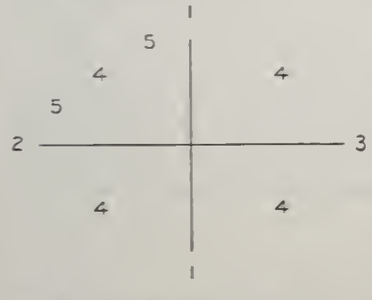
Eucopidæ with numerous lithocysts and numerous simple tentacles. There are *neither lateral nor marginal cirri*. The 4 gonads are developed upon the 4 radial-canals. The stomach is mounted upon a well-developed peduncle. The hydroid is *Phortis* Brooks, 1883.

This genus is very closely related to *Eirene* and to *Tima* of Eschscholtz, 1829, but differs from them in having neither marginal nor lateral cirri. Bigelow, 1909, merges it with *Eirene*.

Phortis gibbosa McCrady.

Non Eirene gibbosa, Eschscholtz, 1829, Syst. der Acal., p. 94.
Phortis gibbosa, McCrady, 1857, Gymn. Charleston Harbor, p. 91.
Eirene gibbosa, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 362.—Agassiz, A., 1865, North Amer. Acal., p. 112.
Irene gibbosa, Haeckel, 1879, Syst. der Medusen, p. 203.
Phortis gibbosa, Brooks, 1883, Studies Biol. Lab. Johns Hopkins Univ., vol. 2, p. 470.

Adult medusa.—Bell about 25 mm. in diameter. Somewhat higher than broad, its outline that of a paraboloid of revolution. There are about 60 long slender tentacles with large basal bulbs. No cirri upon sides of tentacles or upon bell-margin; about 60 lithocysts alternate with the tentacles; each usually contains a single spherical concretion. There are 4 straight, narrow, radial tubes. The manubrium is provided with a wide peduncle, which fills the greater part of the bell-cavity, but it is not very long and does not quite extend to the level of velar opening. Stomach quite large, projecting beyond velar opening. Gonads linear and developed upon outer parts of radial-canals between base of peduncle and bell-margin. Entoderm of gonads and tentacle-bulbs reddish in color.



Hydroid and young medusa.—Brooks, 1883, describes the hydroid stock and young medusa of this species. The hydroid was found at Beaufort, North Carolina, attached to stems of *Aglaophenia*. A long, slender stolon, or hydrorhiza, runs along the stem of the *Aglaophenia* and gives rise, at quite regular intervals, to short, annulated branches, some terminating in hydranths and others in reproductive calycles, which do not differ much from the hydrothecæ either in size or shape. Hydrothecæ are trumpet-shaped, slightly curved, tapering gradually from the base to the wide, flaring, reflected opening. The polypites are long and slender, and have about 12 tentacles with rings of lasso-cells. The reproductive calycles are very similar in size and shape to the hydrothecæ. The reproductive calycle, however, tapers somewhat more gradually toward the pedicel than does the hydrotheca. Annulations run up for half its length or more, and its distal end is less flaring than the hydrotheca. The blastostyle runs along one side of the reproductive calycle and terminates in a club-shaped tip. 3 or 4 medusa-buds develop upon one side of the blastostyle, the oldest being at the distal end. Only one medusa escapes at a time. When set free the exumbrella of the medusa is regularly curved and its height is a little greater than its diameter. The subumbrella, on the other hand, is bent upon itself about half-way up, at an obtuse angle, and the lower or free half of the umbrella is about twice as thick as the upper half. The manubrium is very short and consists of an upper, flat, gastric part which extends outward along the 4 radial tubes for about a sixth of their length, and a mouth-tube about a fifth the height of the umbrella. The mouth-tube is provided with 4 well-developed cruciform lips. The young medusa possesses 10 tentacles, arranged as shown in the diagram. (1, 1) are well developed and are about two or three times as long as the bell-diameter; (2) is shorter, and (3) is still more undeveloped; (4, 4, 4, 4) are mere rudimentary tentacle-bulbs, and (5, 5) are still smaller. None of the tentacles have lateral cirri. There are no lithocysts in the very young medusæ.

These structures develop, however, at a later period. As the medusa develops, the peduncle appears and increases in size, the tentacles increase in number, and the lithocysts develop.

This species has been found by McCrady, 1857, in Charleston Harbor, and by Brooks, 1883, at Beaufort, North Carolina. Our description of the hydroid and young medusa is taken from that of Brooks, 1883 (pp. 470 to 473). Unfortunately the medusa has never been figured. It appears to be distinguished from *P. pyramidalis* by its high bell, few tentacles, reddish color, and large stomach.

Phortis pyramidalis Mayer.

Plate 39, figs. 3-6.

Eutima pyramidalis, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 363.—Agassiz, A., 1865, North Amer. Acal., p. 118.—Haeckel, 1879, Syst. der Medusen, p. 191.

Phortis pyramidalis, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 59, plate 10, figs. 21, 21*a*; 1904, Memoirs Nat. Sci. Museum Brooklyn Institute Arts and Sci., vol. 1, p. 17, plate 3, fig. 25.

Adult medusa (plate 39, fig. 5).—Bell slightly flatter than a hemisphere and attains a diameter of about 35 mm. There are about 100 small, slender tentacles, which lack lateral or marginal cirri. About 100 lithocysts alternate with the equally numerous tentacles. Each lithocyst contains a single spherical concretion. There are 4 narrow radial-canals. The very small stomach is mounted upon a wide, cone-shaped, gelatinous peduncle which fills most of the cavity of the bell and projects outward for a considerable distance beyond the velar opening. The stomach is provided with 4 delicate, crenated lips. The 4 gonads are linear and developed upon the outer parts of the 4 radial-canals near the circular canal.

The stomach, tentacle-bulbs, and gonads are of a delicate blue-green color.

This medusa is very abundant among the Bahamas and Tortugas Islands, and off the Florida coast. At night, when disturbed, it glows with an intense blue-green phosphorescence, far more brilliant than that of any other medusa we have observed.

Young medusa.—In the youngest medusa observed (plate 39, fig. 3) the bell was higher than a hemisphere and 3 mm. in diameter. There was no peduncle and the gelatinous substance was not very thick. There were 4 slender radial tubes and 16 tentacles, only 8 of which had attained to any considerable length, the others being mere basal bulbs. There were about 8 lithocysts, each containing a single spherical concretion.

When the medusa is about 7 mm. in diameter (plate 39, fig. 4) the bell is flatter than a hemisphere. The peduncle is well developed and extends beyond the velar opening. The stomach has grown very little and is, relatively to the size of the medusa, much smaller than in the younger animal. There are 4 recurved lips. There are now about 32 tentacles and 16 lithocysts. Hydroid unknown.

Phortis lactea Mayer.

Plate 40, fig. 2; plate 41, fig. 6.

Phortis lactea, Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 58, plate 40, fig. 133.

Bell is 5 mm. in diameter and sides flange slightly outward at margin. The gelatinous substance is of moderate thickness at the aboral pole, but becomes thin at margin of bell. There are about 18 to 22 short, simple tentacles, the basal bulbs of which are large and swollen. These tentacles are only about one-fifth as long as the bell-diameter. There are neither lateral nor marginal cirri. The lithocysts are slightly more numerous than the tentacles, there being at least 1, and occasionally 2, of these structures between each successive pair of tentacles. Each lithocyst contains a single spherical concretion. Velum well developed. There are 4 straight, slender radial-canals, which extend down the peduncle to the stomach. The peduncle is wide at its base, but not so wide as in *Phortis pyramidalis*. It extends for a short distance beyond the velar opening of the bell. The stomach is cruciform in cross-section, and there are 4 simple recurved lips. The 4 gonads are situated upon the 4 radial-canals, a short distance above their junction with the circular vessel. Each gonad is linear, and in the female the ova are quite conspicuous.

The gonads and stomach are milky in color, while the tentacle-bulbs are cream-colored with greenish or faint salmon-colored entodermal granules.

Found at the Tortugas, Florida, in June and July. The hydroid is unknown.

Phortis palkensis.

Irene palkensis, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 141, plate 3, figs. 12–16.

Bell 20 mm. wide, watch-glass-shaped, 4 times as wide as high. About 50 short tentacles, and 100 to 150 marginal bulbs, all with excretory pores. No cirri. 2 to 4 lithocysts between each successive pair of tentacles; each lithocyst with 2 concretions (range 1 to 4). Stomach on a long, narrow, cylindrical peduncle. 4 short lips with sinuous margin. 4 gonads on the 4 radial-canals extending from the base of the peduncle to near the bell-margin. North coast of Ceylon; March.

Very closely related to *P. ceylonensis*, but distinguished by its lithocysts having more than one concretion and by its numerous marginal bulbs.

Owing to its not having marginal cirri I am inclined to place this medusa in the genus *Phortis*, rather than in *Eirene*.

Phortis ceylonensis.

Irene ceylonensis, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 140, plate 3, figs. 9–11.—Annandale, 1907, Journal and Proc. Asiatic Soc. Bengal, vol. 3, No. 2, p. 79, pl. 2, fig. 5.

Bell flat with thin walls, 15 to 25 mm. wide. About 100 short tentacles, alternating with about 100 lithocysts, each normally having one concretion. Neither marginal nor lateral cirri. Peduncle long, narrow, cylindrical. Stomach short with 4 lips having sinuous margins. 4 radial-canals with 4 gonads upon them from the base of the peduncle to near the bell margin. Colorless.

Ceylon, July to November. When 5 mm. wide the medusa has about 28 tentacles; when 7 mm. wide about 36 tentacles; when 15 mm. wide about 72 tentacles.

Very closely related to *P. palkensis*, but distinguished by the absence of rudimentary tentacle-bulbs, and by the fact that each lithocyst contains only 1 concretion instead of 2 or more as in *P. palkensis*.

Annandale, 1907, found this medusa in great numbers in brackish pools at Port Canning, Lower Bengal, India, where the salinity was only one-third as great as that of sea-water. The medusæ were very sluggish. The hydroid was also found here by Annandale. It is less than 1 mm. high and colorless. Hydrorhiza branched, delicate, adherent to weeds, and gives rise at fairly regular intervals to hydrothecæ and gonothecæ. The hydrothecæ are closed by an operculum formed of a number of convergent pieces and are mounted upon hinged pedicels one-seventh as long as the cup of the theca. The gonothecæ are larger than the hydrothecæ and are club-shaped with a terminal aperture. When set free the medusa has 4 tentacles.

Phortis kambara.

Eirene kambara, Agassiz, A., and Mayer, 1899, Bull. Museum Comp. Zool. at Harvard College, vol. 32, p. 169, plate 8, fig. 29.

Bell flat with sloping sides, and 8 mm. in diameter. About 32 very small, slender tentacles, having well-developed basal bulbs; no marginal cirri. 64 lithocysts, 2 between each successive pair of tentacles, each containing a single spherical concretion. Velum well developed. The 4 radial-canals are straight and narrow, and the gonads occupy their lower (outermost) portions. There is a distinct peduncle. The stomach is simple and has 4 curved lips which are at the level of the velar opening. The entoderm of the basal bulbs of the tentacles and the stomach are turquoise in color.

Single specimen found in Suva Harbor, Fiji Islands, South Pacific, December 29, 1897. This form differs from *Phortis pyramidalis* L. Agassiz, of the West Indies, in that the peduncle is smaller and the stomach larger than in the Atlantic form.

Phortis elliceana Agassiz and Mayer.

Phortis elliceana, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 146, plate 2, figs. 5–7.

Bell much flatter than a hemisphere, about 16 mm. in diameter. The gelatinous substance is thick at the aboral pole, but becomes thinner toward the bell-margin, which is sharp-edged. About 56 hollow tentacle-bulbs. 4 of these are large and situated at the bases of the 4 radial-

canals; 12 others are of medium size, 3 of these being found in each quadrant. There are also about 40 very small rudimentary tentacle-bulbs upon the bell-margin. There are neither lateral nor marginal cirri. About 56 lithocysts alternate in position with the tentacle-bulbs, each containing 2 or 3 spherical concretions. Velum well developed. There are 4 simple,

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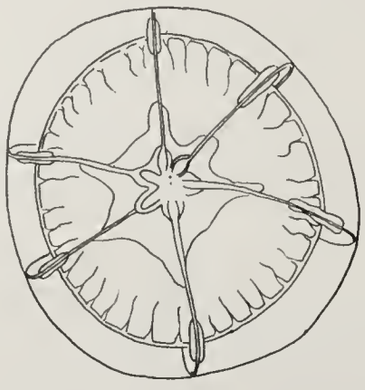


171*a*.

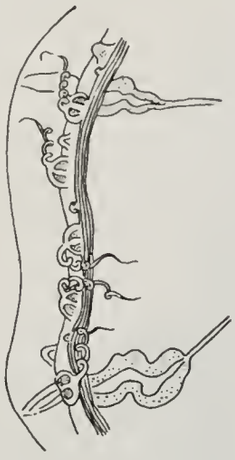


Fig. 170.—*Phortis elliceana*, after Agassiz and Mayer, in Mem. Museum Comp. Zool. at Harvard College.
Fig. 171.—*Irenopsis hexanemalis*, after Maas, in Craspedoten Medusen *Siboga* Exped. Aboral view of medusa.
Fig. 171*a*.—Part of bell-margin of *I. hexanemalis*.

narrow radial-canals and a slender circular vessel. The peduncle is about as long as bell-diameter and projects considerably beyond bell-opening. Basal part of peduncle has the shape of a 4-sided, truncated pyramid, while the distal part is long and tapers gradually toward the stomach. The 4 radial-canals extend down the angles of the peduncle to the stomach. Stomach is short and flaring; 4 well-developed, recurved, folded lips. The 4 gonads are linear and developed upon the subumbrella region of the 4 radial-canals.

The entoderm of tentacle-bulbs and gonads pink, stomach rosin-yellow.

A single specimen of this medusa was found in an open net which was towed from a depth of 150 fathoms to the surface off Funafuti Atoll in the Ellice Islands, tropical Pacific, in December, 1899.

Genus IRENOPSIS Goette, 1886.

Irenopsis, Goette, 1886, Sitzungsber. Akad. Wissen. Berlin, Jahrg. 1886, p. 832.—Chun, 1896, Mitth. Naturhistorischen Museum Hamburg, Bd. 13, p. 5.
Non Ireniopsis, Mayer, 1894, Bull. Mus. Comp. Zool. at Harvard College, vol. 25, p. 238.
Irenopsis, Browne, 1905, Report on Pearl Oyster Fisheries of Gulf of Manaar, Roy. Soc. London, Suppl. Report 27, p. 142.
Irenopsis, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 36.

The type species is *Irenopsis hexanemalis* Goette of the coast of Zanzibar, Indian Ocean, and Malay Archipelago. It is abundant in these regions.

GENERIC CHARACTERS.

Eucopidæ with 6 radial-canals, 6 gonads, 6 lips. No cirri. Numerous lithocysts. Stomach mounted upon a peduncle. Hydroid unknown.

Irenopsis hexanemalis Goette.

Irenopsis hexanemalis, Goette, 1886, Sitzungsber. Akad. Wissen. Berlin, Jahrg. 1886, p. 832.—Chun, 1896, Mittheil. Naturhistor. Mus. Hamburg, Bd. 13, p. 5.
Philalidium tenue (abnormal specimen), Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, part 3, p. 730, plate 54, fig. 4; plate 57, fig. 16.
Irenopsis hexanemalis, Browne, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Supplementary Report 27, p. 142, plate 1, fig. 4; plate 3, figs. 5–8.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 37, taf. 6, fign. 38–40.

Bell flatter than a hemisphere, 12 to 18 mm. wide (see fig. 171). There are 30 to 50 short, slender, tapering tentacles with large, swollen, basal bulbs. These tentacles are less than half as long as bell-radius, their outer ends usually helically coiled. There are 3 or more

marginal bulbs between every 2 tentacles. There is an excretory pore above the base of every tentacle-bulb and rudimentary tentacle. Usually 1, occasionally 2, closed lithocysts between every 2 marginal-bulbs. The lithocysts are very minute and usually contain a single concretion, although occasionally there are 2 to 4 in a lithocyst. There are no marginal cirri. Velum narrow. There are 6 straight, slender radial-canals, 60° apart, and a simple, narrow ring-canal. The stomach is mounted upon a thick conical peduncle, the mouth about at level of velar opening. Stomach very small, but it has 6 long, recurved, lanceolate lips with folded edges. The 6 linear gonads are upon the outer subumbrella halves of the 6 radial-canals, just above the ring-canal. Gonads, stomach, and tentacle-bulbs opaque milky-yellow, other parts colorless.

This medusa is abundant upon the surface along the coasts of the warmer parts of the Indian Ocean from Zanzibar northward to the Malay Archipelago. It is best described and figured by Browne, 1905. It is quite variable. In some specimens the peduncle is well developed, in others it is hardly noticeable. Among 27 specimens studied by Browne from the Gulf of Manaar the radial-canals ranged from 4 to 11. Browne, 1905, states that his "*Phialidium tenue*" is only an abnormal 4-rayed *Irenopsis hexanemalis*.

Genus EIRENE Eschscholtz, 1829.

Eirene, Eschscholtz, 1829, Syst. der Acalephen, p. 94.
Geryonopsis, Forbes, 1848, British Naked-eyed Medusæ, p. 39.
Irenium+Irene, Haeckel, 1879, Syst. der Medusen, pp. 199, 200.
Irene, Bedot, 1901, Revue Suisse de Zool., tome 9, p. 483; *Ibid.*, 1905, tome 13, p. 136 (all papers cited to 1850).

This genus was founded by Eschscholtz, 1829, to include four species of medusæ, all of which had been described under other names by previous authors. *Eirene viridula* is the oldest known species and may be taken as the type of the genus.

GENERIC CHARACTERS.

Eucopidæ with more than 8 lithocysts and with 4 or more tentacles. There are numerous *small marginal cirri*. The gonads are situated upon the 4 radial-canals, but they do *not* extend over the entire lengths of the canals. The stomach is mounted upon a well-developed peduncle. Hydroid undetermined.

Haeckel, 1879, introduced the spelling "*Irene*" although Eschscholtz's original name is *Eirene*.

Eirene is closely related to *Tima*=(*Irenium*+*Tima*) Haeckel, but in *Eirene* the gonads are restricted to limited parts of the lengths of the 4 radial-canals, being commonly best developed upon the subumbrella and not so markedly upon the peduncle. In *Tima*, on the other hand, the gonads extend along the entire lengths of the 4 radial-canals, over both subumbrella and peduncle, from the bell-margin to the corners of the stomach. *Eirene* is chiefly distinguished, however, by the absence of definite longitudinal muscle strands in its tentacles, whereas in *Tima* a prominent band of such muscles extends down the inner (velar) side of each tentacle.

Eirene viridula Eschscholtz.

Oceania viridula, Péron et Lesueur, 1809, Annal. du Mus. Hist. Nat. Paris, tome 14, p. 346.
Eirene viridula, Eschscholtz, 1829, Syst. der Acalephen, p. 94.—(?) Bigelow, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 163, plate 36.
Thaumantias cymbaloidea, Forbes, 1848, British Naked-eyed Medusæ, p. 39, plate 9, figs. 1*a*–1*e*=*Geryonopsis deliculata*, Forbes, *Ibid.*, p. 39.
Geryonopsis forbesii, Van Beneden, 1886, Mém. Acad. Royal. Belgique, tome 36, p. 87, planche 3, figs. 1–7.
Tima pellucida, Schulze, 1872, Zool. Ergeb. Nordsee-Fahrt, p. 138, taf. 2, fig. 6.
Irene viridula, Haeckel, 1879, Syst. der Medusen, p. 202.—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 63, taf. 6, fign. 1, 2.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 483; *Ibid.*, 1905, tome 13, p. 136 (literature cited to 1850).
Irene mollis, Torrey, 1909, University California Publication, Zool., vol. 6, p. 26, fig. 11.

Bell very flat, 25 to 50 mm. wide and about 6 to 15 mm. high. Gelatinous substance thin and of great tenuity. 50 to 60 tentacles not more than a fifth as long as the bell-radius, and about 100 even smaller tentacles not more than half as long as the longer tentacles. All the tentacles have wide, conical, basal bulbs which taper rapidly into the thread-like lash of the tentacle. The 100 smaller tentacles are each flanked by a pair of coiled lateral cirri, but

these are not found at the sides of the larger tentacles. Each tentacle-bulb bears an abaxial excretion papilla. The thread-like lash of each tentacle is ringed by numerous nematocyst-ridges, but has not the longitudinal muscle strand seen in *Tima*. There are about 100 small, vesicular lithocysts, each containing 2 to 4 concretions. The velum is very narrow.

The peduncle is half as long as the bell-radius. It is pyramidal, slender, and half as wide at its base as long. It is much smaller and more slender than the peduncle of *Tima pellucida* with which this medusa has at times been confused. The stomach is about a third as long as the gelatinous peduncle and there are 4 long, lanceolate lips with crumpled margins. The 4 radial-canals are very slender. They extend straight down the perradial sides of the peduncle, but are slightly wavy over the subumbrella. The ring-canal is narrow and simple. The 4 linear, somewhat sinuous gonads are developed upon the subumbrella portions of the 4 radial-canals from near the base of the peduncle to near the circular vessel.

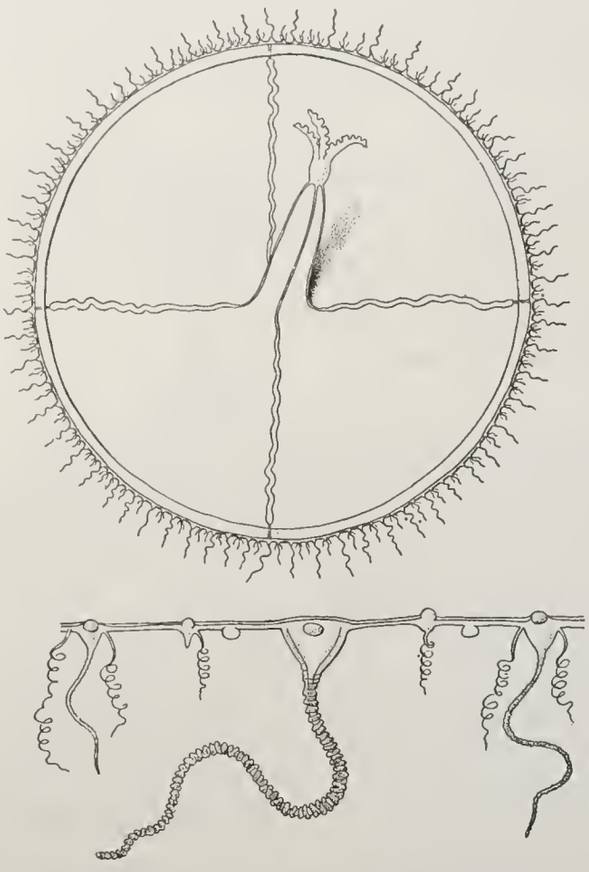


Fig. 172.—*Eirene viridula*. Drawn by the author from a specimen collected by Dr. Lobianco in the Bay of Naples. Oral view of medusa. Enlarged view of part of the bell-margin.

The tentacles, gonads, and stomach are milky-white, green, or reddish.

This medusa is found off the Atlantic coasts of Europe from Helgoland to the Mediterranean. It is occasionally found at Naples, on the surface.

The dimensions of a large specimen in Dr. Lobianco's collection at Naples are as follows: Bell 48.5 mm. wide; peduncle 12 mm. long, and 6 mm. wide at its base; stomach 4 mm. long; long tentacles 5 mm. long; short tentacles 2 or 3 mm. long. The hydroid is unknown. Bigelow, and also Torrey, 1909, find a closely allied medusa with broader peduncle, southwest of the Galapagos Islands, tropical Pacific, and at San Diego, California.

Eirene variabilis.

Plate 38, fig. 4; plate 39, fig. 2.

Eutima variabilis, McCrady, 1857, Gymn. Charleston Harbor, p. 88.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 363.—Agassiz, A., 1865, North Amer. Acal., p. 116.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 396, plate 39, fig. 1; plate 40, fig. 1.
Octorchandra variabilis, Haeckel, 1879, Syst. der Medusen, p. 199.

Adult medusa.—Bell about 30 mm. in diameter and about 3 times as wide as high. The gelatinous substance is quite thick. 16 tentacles with well-developed, hollow, basal bulbs; the tentacles are all of equal length and longer than the bell-diameter. Each basal bulb is flanked by a pair of lateral cirri, and there are also usually 3 small thickenings upon the bell-margin between each successive pair of tentacles. 8 or 12 lithocysts, 2 or 3 in each quadrant. Each lithocyst contains 5 to 8 spherical concretions (see Brooks, 1886). Velum well-developed; 4 narrow, radial tubes. Peduncle conical, about twice as long as bell-height. Stomach small, urn-shaped, 4 crenated, recurved lips. The gonads are developed upon 2 separated regions on each radial-canal. They extend from near the circular vessel to near the base of the peduncle and are also found upon the sides of the peduncle near its proximal end.

The entoderm of the tentacle-bulbs and of the stomach is intense green.

This species has been found by McCrady, 1857, and also by me in Charleston Harbor,

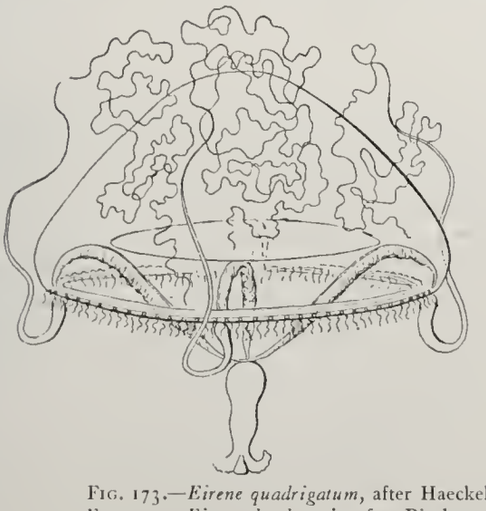
South Carolina, and at Tortugas, Florida. It was found by Brooks, 1886, at Beaufort, North Carolina. It occurs in summer and is a rare medusa.

This medusa has usually been placed in the genus *Eutima*, but I find that when adult it has more than 8 lithocysts, and should, therefore, be included in the closely related genus *Eirene*.

Eirene quadrigatum.

Irenium quadrigatum, Haeckel, 1879, Syst. der Medusen, p. 199, taf. 12, fign. 12, 13.

Bell somewhat flatter than a hemisphere, 15 mm. wide. Gelatinous substance very thick, bell-cavity very shallow. There are 4 very long tapering tentacles, with hollow, conical, basal bulbs. 120 to 160 helically coiled marginal cirri, and 30 to 40 conical excretion papillæ upon the bell-margin. Also 60 to 80 lithocysts each with 4 to 6 concretions. The stomach is pyriform, about half as long as the bell-radius, and provided with 4 short, complexly folded lips. It is mounted upon a wide, bluntly conical, gelatinous peduncle, about twice as wide as long and about two-thirds as wide as the bell-diameter at its base. The gonads are 4 small, complexly folded bands upon the 4 radial-canals. They occupy nearly the entire lengths of the canals, leaving both ends free. Stomach, gonads, and tentacle-bulbs greenish. West coast of Africa, Mogador, Morocco. Development unknown.



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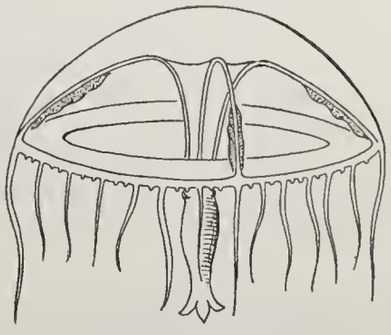

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Fig. 173.—*Eirene quadrigatum*, after Haeckel, 1879.
Fig. 174.—*Eirene danduensis*, after Bigelow, in Bull. Mus. Comp. Zool. at Harvard College.

Eirene danduensis Bigelow.

Eirene danduensis, Bigelow, H. B., 1904, Bull. Museum Comp. Zool. at Harvard College, vol. 39, p. 254, plate 1, fig. 5; plate 2, fig. 6.
Eirene danduensis (*palkensis*) 1909, Mem. *Ibid.*, p. 164.

Bell 25 mm. wide and 8 mm. high, with fairly thin walls. 32 tentacles, the 4 radial ones being a fourth longer than the others. Each tentacle-bulb is flanked by a pair of small cirri. About 70 small papillæ scattered irregularly along the margin. 32 lithocysts, 8 in each quadrant. Each lithocyst contains about 5 spherical concretions. Peduncle long and conical, extending well beyond velar opening. Stomach about half as long as peduncle, but may be extended to nearly double this length. There are 4 simple lips. The 4 spindle-shaped gonads occupy the distal two-thirds of the radial-canals. The bell is colorless, gonads bluish-green. Found off Haddummati Atoll, Maldive Islands, Indian Ocean, in January. This species is distinguished by the great length of the peduncle and stomach. It may prove to be identical with *Phortis palkensis*, but the latter appears to lack marginal cirri.

Eirene medusifera Bigelow.

Eirene medusifera, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 161, plate 37, figs. 1 to 8.

Bell 8 mm. wide, nearly hemispherical, gelatinous substance not thick. About 21 tentacles with swollen, conical bases and thread-like extremities about as long as the bell-radius. There are also a few marginal knobs, but these are probably only young tentacles

in process of development. All of the tentacles and knobs are flanked by one or two pairs of lateral cirri. The lithocysts are about as numerous as the tentacles and alternate with them. Each contains 2 to 5 or more spherical concretions. The peduncle is conical and reaches to level of bell opening. Manubrium short, with 4 simple lips. The 4 radial-canals are straight and slender. The 4 cylindrical gonads occupy the distal thirds of the radial-canals, but do not quite extend to the bell-margin. Clusters of medusa buds develop upon the gonads. When set free each budded medusa has 4 tentacles flanked by cirri, but has no peduncle. Gonads and manubrium pale yellowish, other parts colorless. Common in Acapulco Harbor, Pacific coast of Mexico. This species and *Eucheilota paradoxica* are the only Leptomedusæ known to produce free medusa buds.

Genus TIMA Eschscholtz, 1829.

Tima, Eschscholtz, 1829, Syst. der Acalephen, p. 103.—de Blainville, 1834, Manuel d'Actinologie, p. 285.—Lesson, 1843, Hist. Zooph. Acal., p. 333.—Forbes, 1848, British Naked-eyed Medusæ, p. 37.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 362.—Agassiz, A., 1865, North Amer. Acal., p. 113.—Haeckel, 1879, Syst. der Medusen, p. 203.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 152.—Browne, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 170.

This genus was founded by Eschscholtz, 1829, for *Tima flavilabris* of the North Atlantic Ocean, north of the Azores, but *Tima* (*Dianæa*) *lucullana* Delle Chiaje, 1822, which is better known, had best be taken as the type of the genus.

GENERIC CHARACTERS.

Eucopidæ with more than 8 lithocysts and with 4 or more tentacles with a band of longitudinal muscles on their velar sides. There are numerous warts or cirri upon the bell-margin. The 4 gonads are developed upon the *entire* lengths of the 4 radial-canals. The stomach is mounted upon a gelatinous peduncle. The hydroid is probably *Campanulina*.

This genus is closely related to *Eirene*, but is distinguished by having the gonads upon the *entire* lengths of the radial-canals instead of being developed only upon restricted lengths of the canals as in *Eirene*. The chief distinction between these genera is, however, that in *Tima* each tentacle has a well-developed band of longitudinal muscle fibers upon its axial, inner (velar) side.

Tima lucullana.

Dianæa lucullana, Delle Chiaje, 1822, Mem. Storia e Notomia Anim. senza Vert. Regno Napoli, tav. 74, figs. 1, 2.
Geryonia pellucida, Will, 1844, Horæ tergestinæ, p. 70, taf. 2, fig. 8.
Geryonopsis pellucida, Forbes, 1848, British Naked-eyed Medusæ, p. 40.
Tima pellucida, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 253.
Irene pellucida, Haeckel, 1879, Syst. der Medusen, p. 201, taf. 12, fign. 1, 2; also, *Tima cari*, 1864, Jena. Zeit. für Naturwis., Bd. 1, p. 332.
Irene (*Tima*) *pellucida*, Claus, 1881, Arbeit. Zool. Inst. Wien, Bd. 4, p. 102, taf. 3, fign. 21–30 (growth of the medusa).
Tima pellucida (*Campanulina acuminata*), Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 358.
(?) *Irene pellucida*, Goette, 1886, Sitzungsber. Akad. Wissen. Berlin, Jahrg. 1886, p. 833 (from the coast of Zanzibar).
Tima pellucida, Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, p. 54, etc. (early development of the larva).

The following description is derived from a study of a well-preserved specimen of this medusa collected at a considerable depth in the Bay of Naples by Dr. S. Lobianco of the Stazione Zoologica.

Bell 74 mm. wide, flatter than a hemisphere, with relatively thin walls; 10 to 13, usually 12, tentacles in each quadrant, which tentacles when contracted are about one-third as long as bell-radius; each tentacle bends sharply inward toward the center of the bell at a short distance beyond its point of origin. A well-defined strand of longitudinal muscle-fibers extends down the velar (axial) side of each tentacle. There is a deep, longitudinal groove down the abaxial (exumbrella) side of each tentacle. There are numerous elongate, wart-like nematocyst swellings, extending obliquely across the tentacles on both sides of this abaxial groove. In addition to the tentacles there are about 7 times as many (336) small, wart-like, rudimentary tentacles upon the bell-margin. (See text-figure 177.)

Haeckel states that there are 40 to 60 lithocysts, each with 2 to 4 concretions, but I believe his studies are based upon immature medusæ. Unfortunately the formalin, in which Dr. Lobianco's specimen is preserved, has destroyed the lithocysts. The velum is of only moderate width.

Synoptic Table of the Described Species of Tima.

	Tima bairdii Forbes, 1848.	Tima formosa L. Agassiz, 1862.	Tima teuscheri Haeckel, 1879.	Tima flavilabris Eschscholtz, 1829.	Tima lucullana = Dianæa lucullana Delle Chiaje, 1822.
Diameter of bell in mm.	50	100	40	80	74
Length of peduncle in terms of bell-radius (*r*).	2 *r*	2 *r*	2 *r*	*r*+	2 *r*
Greatest width of peduncle in terms of bell-radius (*r*).	0.5 *r*	0.5 *r*	0.5 *r*	1.25 *r*	0.75 *r*. 4-sided pyramidal.
Character of stomach and lips.	Stomach small. Lips large and with folded edges.	As in T. bairdii.	As in T. bairdii.	As in T. bairdii.	Lips not so prominent as in T. bairdii.
Number and character of tentacles.	16 large tentacles.	32; 8 long, 8 medium, 16 short.	48; 8 large, 40 small, short, conical.	80 small.	48; all large and of same size.
Number of marginal cirri.	?	None.	60 to 80 irregularly placed on the bell-margin.	None.	None.
Number of rudimentary tentacle-bulbs = "Marginal warts."	?	96	None.	?	About 336.
Number of lithocysts.	?	128	70 to 80	?	40 to 60 ?
Number of concretions in each lithocyst.	?	15 to 20	2 to 4	?	2 to 4 ?
Character of gonads.	Folded, linear, narrow near stomach, wider outwardly.	Thicker, wider, and more complexly folded than T. bairdii.	As in T. formosa.	As in T. formosa.	Narrower than in T. bairdii.
Color.	Gonads milky-white, tentacles creamy-pink.	Gonads as in T. bairdii.	?	Gonads white; stomach and lips sulphur-yellow.	Gonads, stomach, and tentacle-bulbs white.
Where found.	Coast of Scotland in autumn and winter.	Atlantic coast of North America from Woods Hole northward. Mature early in spring.	Coast of Brazil, north of equator.	Northeast of the Azores in May.	Mediterranean.
Remarks.	Probably young of T. formosa L. Agassiz.	Egg develops into Campanulina-like hydroid.	Distinguished by its 48 tentacles and its spiral, marginal cirri. Closely related to T. formosa.	Distinguished by its 80 tentacles, all short and small.	

The peduncle is large, 4-sided, and pyramidal. It is nearly as wide as the bell-radius at its base, and about 1.5 times as long as the bell-radius. The 4-sided shape of the pyramidal peduncle causes it to project outward over the floor of the subumbrella more in the perradii than in the interradii, and this gives the appearance of 4 bays where the peduncle joins the subumbrella. This is well shown in Delle Chiaje's good figure, published in 1822.

The 4 linear sinuous gonads extend down the entire lengths of the 4 radial-canals from the angles of the stomach to the circular vessel. They are narrower and not so complexly folded as in *T. formosa*. The stomach is not quite one-third as long as the bell-radius and the 4 recurved lips are not so large or with such complexly folded margins as are seen in *T. formosa* of America.

The color of the entodermal parts of the tentacle-bulbs, gonads, and stomach is milky-white, all other parts being of a glassy transparency. Haeckel states, however, that light-green, blue, or yellow coloration may also exist.

This species is found in deep water in the Mediterranean. Goette describes a similar medusa from the coast of Zanzibar.

Claus, 1881, studied the growth of the Mediterranean medusa. When 1.5 mm. wide there are only 4 radially placed tentacles, flanked by 8 lithocysts, each with a single concretion.

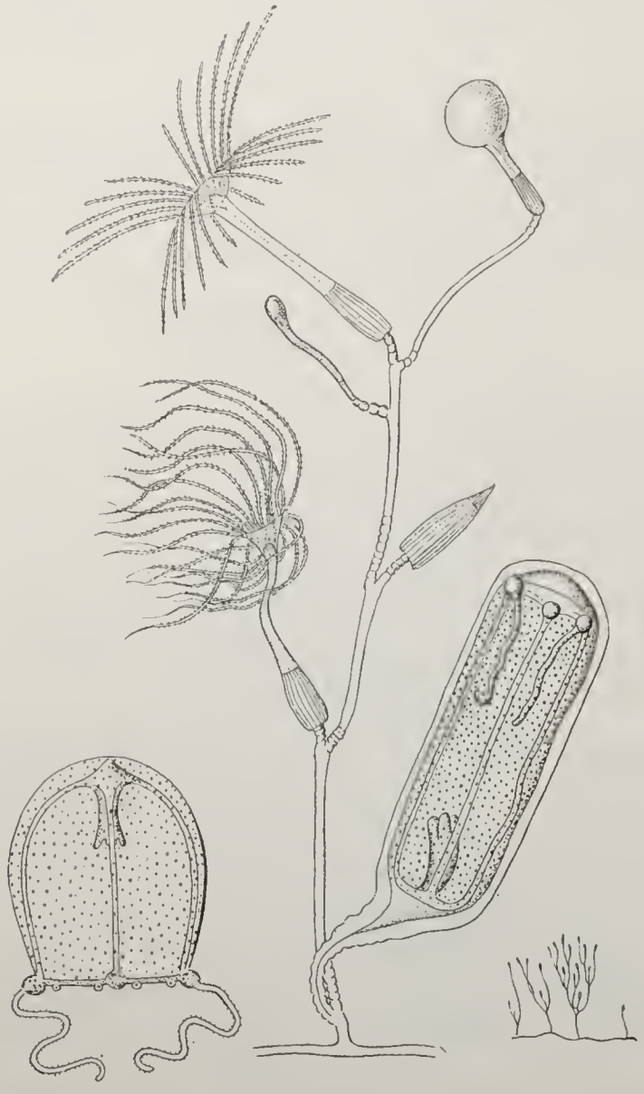


Fig. 175.—"*Campanulina acuminata*," after Hincks, in British Hydroid Zoophytes. This may be the hydroid of *Tima* or *Eirene*. Hydroid and young medusa.

The stomach is small and lacks a peduncle, and there are 4 short lips. The bell is then higher than a hemisphere, with thin walls, and there are no gonads upon the 4 radial-canals and no marginal cirri.

Metschnikoff, 1886, found that the entoderm of the planula is formed by ingression of cells from the hinder end of the spindle-shaped, one-layered larva. According to Graeffe, 1884, the hydroid of *E.* "*pellucida*" is possibly *Campanulina acuminata* Alder.

The dimensions of a mature medusa from Naples are as follows: Bell 74 mm. wide, 31 mm. high. Peduncle 31 mm. wide at its base and 49 mm. long. Stomach 11 mm. long. Contracted tentacles 13 mm. long.

Tima formosa L. Agassiz.

Plate 41, figs. 1-3.

Tima formosa, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 362.—Agassiz, A., 1865, North Amer. Acal., p. 113, figs. 164-172.—Verrill, 1873, Report Commiss. Fish and Fisheries for 1871-72, p. 449.—Haeckel, 1879, Syst. der Medusen, p. 205.—Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 157, plate 6, figs. 1, 4-6.—Nutting, 1901, Bull. U. S. Fish Commiss. for 1899, vol. 19, p. 379, fig. 96.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 47, plate 4, fig. 2.

(?) *Tima bairdii* (young medusa), Forbes, 1848, British Naked-eyed Medusæ, p. 37, plate 5, figs. 1-1*b*.

Adult medusa (plate 41, fig. 1).—This is one of the largest hydromedusæ found upon the coast of the United States. The bell is about 100 mm. in diameter and 65 mm. in height. The gelatinous substance is thick at the apex, but gradually becomes thinner toward margin of bell. There are normally 32 well-developed tentacles; 8 of these are about as long as the bell-diameter, 8 others about half as long, and the 16 others about one-quarter as long as bell-diameter. The basal bulbs of the tentacles are long, fleshy, and ribbon-like, with a strand of longitudinal muscle fibers on their inner (velar) sides and their distal ends are usually

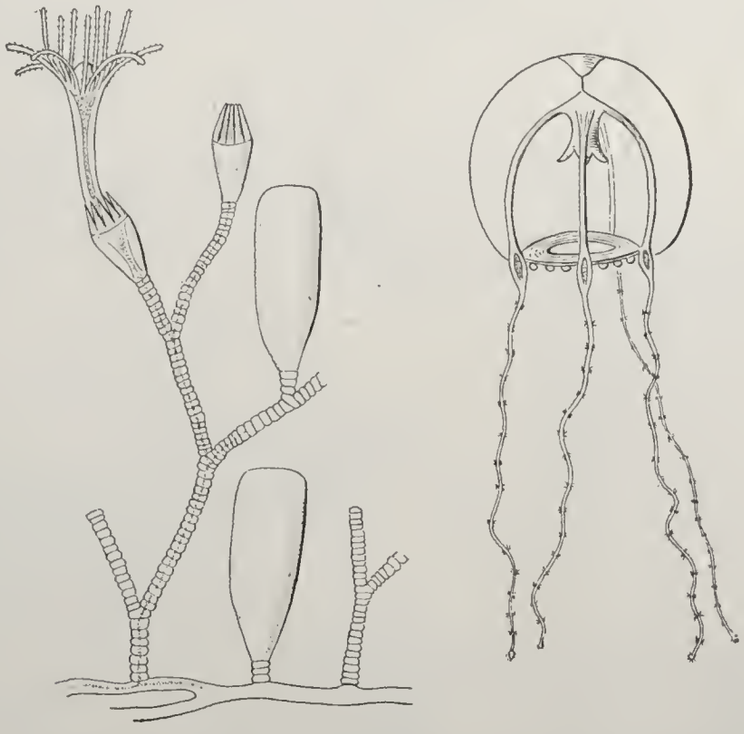


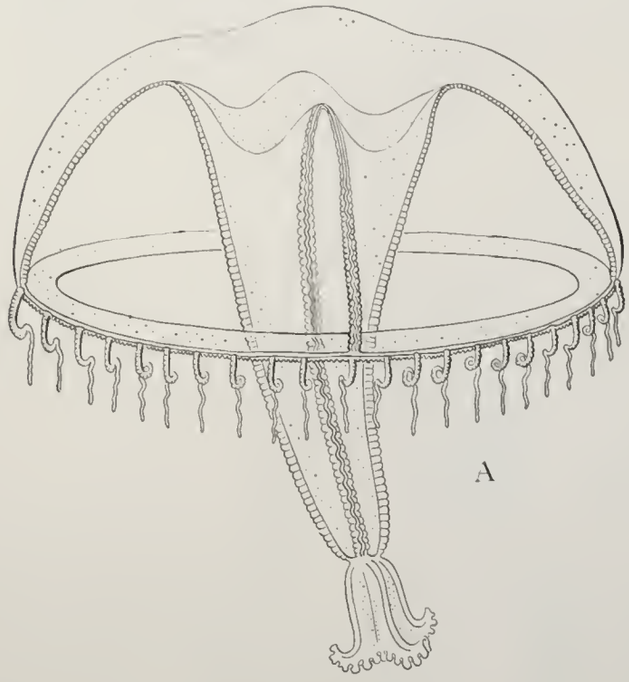
Fig. 176.—Hydroid and medusa of "*Campanulina repens*," after Hincks, in British Hydroid Zoophytes. This may be the hydroid of *Tima* or *Eirene*.

turned upward toward the bell-margin (plate 41, fig. 2). The main shaft of the tentacle is long and contractile and hangs downward from the turned-up end of the basal bulb. The basal bulbs and tentacle-shafts are hollow. There are no lateral cirri at the sides of the tentacles, but there are 3 very small rudimentary protuberances upon the bell-margin between each successive pair of tentacles. Thus in all there are 96 of these small protuberances which never increase in size and are evidently rudimentary tentacles. There are 128 lithocysts alternating in position with the 128 functional and rudimentary tentacles. Each lithocyst contains 15 to 20 angular concretions, arranged in a semicircle near the periphery of the cavity. Velum well developed. There are 4 straight, narrow, radial tubes. A wide, conical peduncle projects considerably beyond the velar opening. The stomach is quadrangular in cross-section and provided with 4 long, folded, curtain-like lips. The 4 gonads are situated upon nearly the whole length of the 4 radial-canals. They are longer than the canals upon which they lie, and are, therefore, deflected from side to side in sinusoidal curves. In the female the eggs are large and prominent.

Gonads and stomach opaque and cream-colored; tentacles delicate creamy-pink. All other parts of the medusa are as transparent as glass.

Hydroid and young medusa.—The hydroid of this species has been obtained from the egg by A. Agassiz, 1865. The egg develops into a pear-shaped planula which grows to be very long and narrow before it becomes attached. The hydroid is very slender and the hydrothecæ are cup-shaped. The polypites are long and slender, and there are about 12 long, delicate tentacles which are covered with prominent nematocyst-capsules. A web connects the tentacles at their bases, but this may be an embryonic feature. At the end of 6 months the hydroid formed small tufts barely perceptible to the naked eye. Medusæ were not developed upon these reared specimens.

In the young medusa 35 mm. in diameter there are no traces of the gonads. The peduncle is short and extends only about three-quarters the distance from the inner apex of the bell-cavity to the velar opening. The 4 lips are by no means so large as in the adult. There are 16



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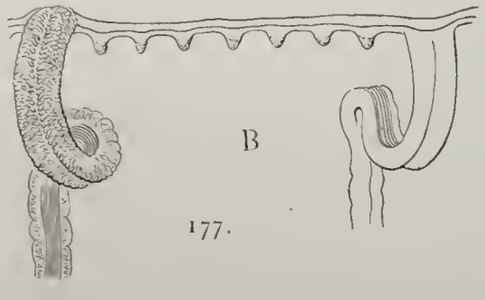

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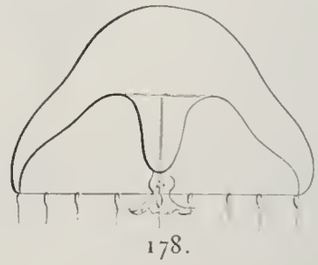

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FIG. 177.—*Tima lucullana*, drawn by the author from a specimen collected by Dr. Lobianco, at Naples, Italy. A, side view of medusa, natural size. B, part of bell-margin, lithocysts not shown.

FIG. 178.—Young medusa of *Tima formosa*, after A. Agassiz, in North American Acalephæ.

tentacles with well-developed basal bulbs, and according to A. Agassiz there are no lithocysts. Fewkes, however, maintains that in this stage there are 2 lithocysts between each successive pair of tentacles and that each lithocyst contains 7 concretions.

This medusa appears in its mature form upon the New England coast in the early spring months. It is common in Buzzard's Bay and Newport Harbor in April and May, but disappears before the first of June. It has, however, been found north of Cape Cod, in Massachusetts Bay in autumn and winter.

According to Fewkes, 1881, if the stomach of *Tima* be lost it is replaced in 4 or 5 days. The formation of the new stomach begins simultaneously at 4 areas which are near the terminations of the 4 radial tubes, and they increase in size and join at their sides, thus regenerating the stomach.

Tima bairdii Forbes.

Dianæa bairdii, Johnston, 1833, London's Magazine of Nat. Hist., vol. 5, p. 320, fig. 41.
Tima bairdii, Forbes, 1848, British Naked-eyed Medusæ, p. 37, plate 5, figs. 1–1*b*.—Haeckel, 1879, Syst. der Medusen, p. 205.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 151 (citation of references, 1833–1850).

For description see synoptic table of species of *Tima*. This form has been seen occasionally off the coast of Scotland. It may prove to be the young of *Tima formosa* of the American North Atlantic. There is no modern description of the European medusa, and the animal is probably an Arctic form which occasionally appears upon the coast of Scotland in autumn and winter, but is more commonly found in the cold water of the coast of the New England States.

Tima flavilabris Eschscholtz.

Tima flavilabris, Eschscholtz, 1829, Syst. der Acalephen, p. 103, taf. 8, fig. 3.—De Blainville, 1834, Man. d'Actinologie, p. 286, plate 38, fig. 1.—Haeckel, 1879, Syst. der Medusen, p. 204.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 132 (references 1829–1850).

For description see synoptic table of species of *Tima*. This "species" was found by Eschscholtz northeast of the Azores in May; I am inclined to believe that it is only the young of *T. formosa* L. Agassiz.

Tima teuscheri Haeckel.

Tima teuscheri, Haeckel, 1879, Syst. der Medusen, p. 206, taf. 12, fign. 3–5.

Medusa bell-shaped, about half as high as wide, being 20 mm. high and 40 mm. in diameter. 8 large tentacles, 4 radial and 4 interradial; these principal tentacles are about as long as the bell-diameter, their basal bulbs are long and conical and about twice as wide as the gonads. In addition to the 8 long tentacles, there are 40 short ones about a fifth as long as bell-diameter and with thick conical bases. There are also two rows of 60 to 80 conical nematocyst-warts upon the bell-margin, and between them 60 to 80 short, spiral cirri, irregularly placed along the margin. The 70 to 80 lithocysts have each 2 to 4 spherical concretions. Velum well developed. Peduncle 4-sided and pyramidal, about 3 times as long as broad, and in length about equal to bell-diameter. Stomach very small, nearly spherical, 4 wide lance-like lips, with curved, folded edges, about a fourth as long as bell-diameter.

Fig. 179.—*Tima teuscheri*, after Haeckel, 1879.

Haeckel describes this species from a single poorly preserved specimen found off the coast of Brazil in N. lat. 3°, W. long. 25°. Our account is a translation of his description.

Family ÆQUORIDÆ Eschscholtz, 1829.

Æquoridæ (in part), Eschscholtz, 1829, Syst. der Acalephen, p. 108.
Æquoridæ, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 359.—Agassiz, A., 1865, North American Acalephæ, p. 95.—Haeckel, 1879, Syst. der Medusen, p. 207.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., pp. 6, 7; 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, pp. 21–24; 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 44.

FAMILY CHARACTERS.

Leptomedusæ with lithocysts and with numerous (8 to 100 or more) simple or branched radial-canals upon which the gonads are developed.

These medusæ are probably derived from the Eucopidæ through the multiplication of the 4 primitive radial-canals. In their youngest stages, indeed, the medusæ of the Æquoridæ have only 4 radial-canals, but these increase by the growing outward of new canals from the stomach-margin. Thus the medusa has at first 4, then 8, 16, 32, etc., radial-canals, although this increase is usually irregular in its later stages. The medusæ appear to develop through alternations of generations from Campanularian hydroids, and asexual budding of daughter medusæ is unknown in the medusa stage of the Æquoridæ.

The medusæ of the Æquoridæ display a remarkable range of individual variability, both of form and color—this being correlated with the multiplicity of their parts such as radial-canals, tentacles, gonads, lithocysts, lips, etc. This high degree of variability has caused much confusion in the synonymy, for "new species" have frequently been described from mere growth-stages or varieties of one and the same medusa. This confusion is most noteworthy in the genus *Æquorea*.

The lithocysts in the Æquoridæ consist of closed velar vesicles containing concretions of ectodermal origin. Excretory papillæ are commonly seen upon the inner (subumbrella) side of the ring-canal at the bases of the tentacles.

Following is a synopsis of the genera of the Æquoridæ:

Octocanna Haeckel, 1879. 8 simple radial-canals, which arise separately from the periphery of the stomach. 8 lips. No ocelli.
Octogonade Zoja, 1896. Similar to *Octocanna*, but the marginal sense-organs are provided with ocelli as well as with lithocysts.
Stomobrachium Brandt, 1835 = *Stomobrachium*+*Staurobrachium* Haeckel, 1879. 8 or more simple radial-canals which arise separately and at equal intervals from the periphery of the stomach. 4 lips.
Halopsis A. Agassiz, 1863. Numerous radial-canals, which arise in 4 groups from the 4 perradial corners of the stomach. 4 lips.
Æquorea Péron and Lesueur, 1809 = *Æquorea*+*Rhegmatodes*+*Mesonema*+*Polycanna* Haeckel, 1879. More than 8 simple radial-canals which arise separately from the periphery of the stomach. More than 4 lips. Subumbrella smooth without gelatinous protuberances. Hydroid is *Campanulina*.
Zygodactyla Brandt, 1835; *sensu* Agassiz, 1862. Similar to *Æquorea*, but with interradial rows of wart-like protuberances upon the floor of the subumbrella.
Zygocanna = *Zygocanna*+*Zygocannota* Haeckel, 1879. With bifurcated or branched radial-canals which arise at equal intervals from the periphery of the stomach. The stomach lacks a peduncle. More than 4 lips.
Zygocannula Haeckel, 1879. Similar to *Zygocanna*, but the stomach is mounted upon a gelatinous peduncle.

Genus OCTOCANNA Haeckel, 1879.

Octocanna, Haeckel, 1879, Syst. der Medusen, p. 213.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10. p. 38; Revue Suisse de Zool., tome 14, p. 94.—Browne, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Roy, Soc. London, Suppl. Report No. 27, p. 145.—Bigelow, 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 168.

Haeckel establishes this genus for two medusæ, the first one being called *Octocanna octonema* and the second *O. polynema*. *O. octonema* is probably the young of *O. polynema* and the type species becomes *O. polynema* of the Indian Ocean. Haeckel states that there are 4 lips, but the recent researches of Maas and Browne show that there are 8 lips.

GENERIC CHARACTERS.

Æquoridæ with 8 simple radial-canals, which arise separately, 45° apart, from the periphery of the stomach. 8 lips. Lithocysts without ocelli. Manubrium without a peduncle.

This genus bears a close resemblance to *Octogonade* Zoja, 1896, but in *Octogonade* the marginal sense-organs are provided with ocelli as in *Tiaropsis*, whereas in *Octocanna* there are no ocelli.

All species of *Æquorea* pass through an "*Octocanna* stage" in their ontogeny, and indeed *Octocanna* may be regarded as only a special form of *Æquorea*, which becomes mature with 8 radial-canals.

Octocanna polynema Haeckel.

Octocanna polynema, Haeckel, 1879, Syst. der Medusen, p. 214.—Browne, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Supplementary Report 27, Roy. Soc. London, p. 144, plate 2, figs. 8–10.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 38; 1906, Revue Suisse de Zool., tome 14, p. 95, plate 3, fig. 10.—(?)Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 169, plates 6 and 38.

Bell about 12 to 25 mm. wide and 4 to 6 mm. high, with thick, gelatinous walls. 32 to 80 filiform tentacles with swollen basal bulbs; the tentacles are about half as long as bell-radius. The bulbs have well-developed, excretory papillæ. There are no cirri nor rudimentary tentacle-

bulbs, except small ones destined to develop into large tentacles (Maas). Browne, however, describes rudimentary tentacle-bulbs 3 to 4 times as numerous as the tentacles. The lithocysts are somewhat more numerous than the tentacles and are situated upon the bell-margin, one or two being found between each successive pair of tentacles. Each lithocyst usually contains 2 concretions, rarely 1 or 3. There are 8 straight, narrow radial-canals and a simple, slender ring-canal. Stomach large, 8-sided, and the 8 radial-canals extend inward as 8 grooves in the floor of the stomach and meet at the center. There are 8 small lips. The 8 gonads are spindle-shaped with blunt outer ends. They begin in the middle third of the radial-canals and extend almost to the end of the radial-canals near the ring-canal.

The medusa is colorless. The preserved specimens studied by Maas exhibited a light brownish-green hue in their entodermal parts.

This medusa is found in the Malay Archipelago and off Ceylon. Browne gives a clear figure and description based upon 3 specimens from Ceylon and the Gulf of Manaar; and Maas gives a good account of specimens from New Guinea and the Malay Archipelago.

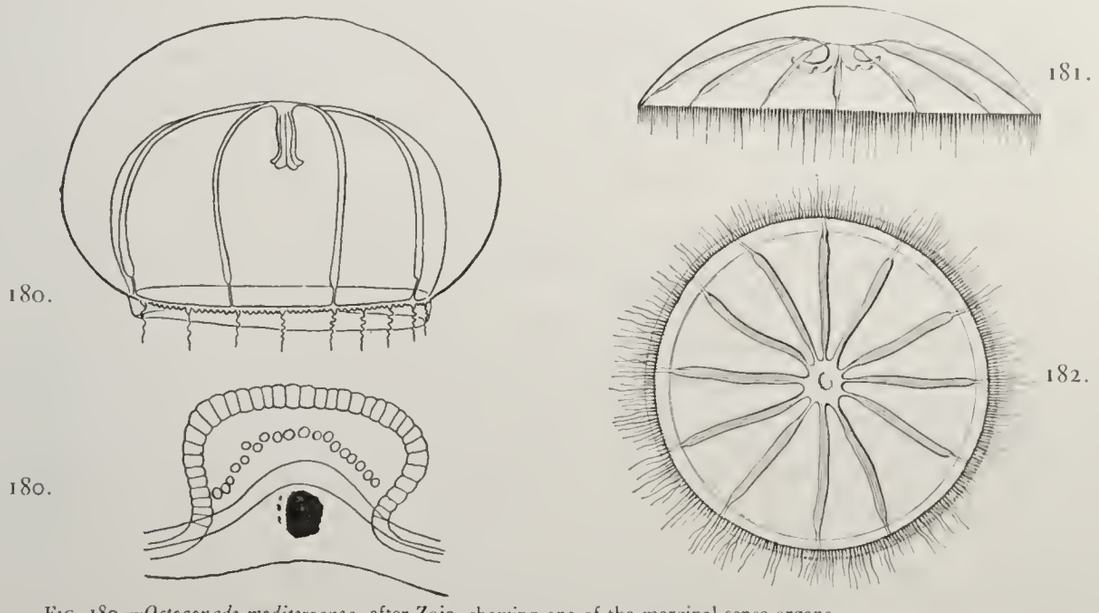


Fig. 180.—*Octogonade mediterranea*, after Zoja, showing one of the marginal sense-organs.
Fig. 181.—*Stomobrachium tentaculatum*, after A. Agassiz, in North American Acalephæ. Side view of the medusa.
Fig. 182.—*Stomobrachium tentaculatum*, oral view, after A. Agassiz, in North American Acalephæ.

Bigelow, 1909, describes a quite similar medusa from Acapulco Harbor, Pacific coast of Mexico, but the gelatinous substance is very thick, the bell being 10 mm. high and 8 mm. wide with a very shallow bell-cavity, thus resembling a specimen referred to *O. polynema* by Browne. Bigelow's medusæ had only 8 large radial tentacles and 8 to 24 marginal bulbs, all bearing excretory papillæ. 8 mature gonads. Bigelow's medusæ may be a variety of *O. polynema*, but the differences between them and the typical form are so marked that we may be obliged to consider them as being specifically distinct.

Genus OCTOGONADE Zoja, 1896.

Octogonade, Zoja, 1896, Bolletino Scientif. Pavia, anno 17, p. 101.

The type species and only known form is *O. mediterranea* Zoja, from Messina, Sicily.

GENERIC CHARACTERS.

Æquoridæ with 8 simple radial-canals arising separately, 45° apart, from the periphery of the stomach. Numerous lithocysts each with 12 to 20 concretions and an ocellus. Numerous tentacles. 8 lips. No peduncle.

The marginal sense-organs appear to resemble those of *Tiaropsis*. The genus *Octogonade* is distinguished from *Octocanna* solely by its marginal ocelli.

Octogonade mediterranea Zoja.

Octogonade mediterranea, Zoja, 1896, Bolletino Scientif. Pavia, anno 17, p. 101, 1 tav., 6 fig.

Bell somewhat higher than a hemisphere, with bulging sides and thick walls; evenly rounded, without an apical projection. 60 to 70 mm. wide. 16 tentacles with hollow, tapering basal bulbs, shorter than the bell-radius, and numerous small, tapering, rudimentary tentacle-bulbs (150 or more). 50 to 60 large, marginal lithocysts, each containing 12 to 20 concretions, and a large ocellus. Apparently these marginal sense-organs are similar in structure to those of *Tiaropsis*. These lithocyst-sacs are somewhat irregularly placed between the tentacles. Velum well developed. 8 slender, straight radial-canals and a ring-canal. Manubrium short, tubular, with 8 radial-canals extending from the sides of the stomach nearly to the circular vessel. Color of entoderm pale white. Found at Messina, Italy, February to March. (See fig. 180.)

Genus STOMOBRACHIUM Brandt, 1835.

Stomobrachium, Brandt, 1835, Mém. Acad. Impériale des Sci. St. Pétersbourg, Sci. Nat., sér. 6, tome 2, p. 220; *Ibid.*, 1838, tome 4, p. 358.—Gould, 1841, Report Invertebrata Massachusetts, p. 349.—Lesson, 1843, Hist. Zooph. Acal., p. 315.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Agassiz, A., 1865, North Amer. Acal., p. 98.
Stomobrachium + *Staurobrachium*, Haeckel, 1879, Syst. der Medusen, pp. 223, 224.

The type species is *Stomobrachium lenticulare* Brandt, from the Falkland Islands.

GENERIC CHARACTERS.

Æquoridæ with 8 or more simple, unbranched canals which arise separately and at equal intervals from the margin of the stomach. With 4 lips. With numerous tentacles and marginal lithocysts. Development unknown.

This genus is distinguished from *Æquorea* by having but 4 lips, and from *Halopsis* by the fact that its radial-canals arise separately, not in clusters from the periphery of the stomach. Haeckel would institute a new genus, *Staurobrachium*, for medusæ resembling Brandt's *Stomobrachium*, but with 16 or more radial-canals, while according to Haeckel's system *Stomobrachium* is restricted to include only medusæ with 12 radial-canals. A broader definition seems desirable, for there is no place in Haeckel's system for medusæ which may possibly be discovered with less than 12, or with 13 to 15, radial-canals, and considering the extreme variability in numbers of these structures in Æquoridæ, it is important that we should define our genera so as to include a considerable range in number in the radial-canals.

Stomobrachium lenticulare Brandt.

Stomobrachium lenticulare, Brandt, 1835, Recueil Actes Sci. publiques Acad. Imp. Sci. St. Pétersbourg, p. 20 (of the "separate"); 1838, Mém. Acad. Impériale des Sci. St. Pétersbourg, Sci. Nat., sér. 6, tome 4, p. 358, taf. 3, fign. 6, 7.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Haeckel, 1879, Syst. der Medusen, p. 224.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 148 (literature to 1850).
Stomobrachium lenticularis, Lesson, 1843, Hist. Zooph. Acal., p. 315.
(??) *Stomobrachium tentaculatum*, Agassiz, A., 1865, North Amer. Acalephæ, p. 98, figs. 140–142.

Bell flat, hour-glass-shaped, about 30 to 40 mm. wide, and 10 to 12 mm. high. 150 to 200 short tentacles. 12 radial-canals. The stomach is a small, flat sack, and there are 5 to 6 small triangular lips, with thin edges slightly folded. There are 12 linear, cylindrical gonads upon the mid-regions of the radial-canals. This species is found off the Falkland Islands, South Atlantic coast of South America.

Stomobrachium tentaculatum Agassiz, from Massachusetts Bay, Atlantic coast of America, is very closely related to, if not identical with, this species. Brandt's medusa has not been seen since he described it.

Stomobrachium tentaculatum L. Agassiz.

(?) *Medusa bimorpha*, Fabricius, 1780, Fauna groenlandica, No. 356.
Stomobrachium lenticulare, Gould, 1841 (*non* Brandt), Report Invert. Anim. Mass., p. 349.
Stomobrachium tentaculatum, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Agassiz, A., 1865, North Amer. Acal., p. 98, figs. 140–142.—Haeckel, 1879, Syst. der Medusen, p. 224.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 51.

Adult medusa.—Bell about 45 mm. in diameter, about 3 to 4 times as wide as high. The gelatinous substance is not very thick. More than 400 slender tentacles of various sizes; these are not capable of much expansion, and when contracted the extremities are coiled helically. Velum small. 12 straight radial-canals, upon almost the whole length of which the gonads are developed. Stomach is small, not more than one-seventh as wide as bell-diameter. 4 large, triangular, crenated lips, trending in the directions of 4 of the radial-canals and placed at right angles to one another. The medusa is colorless.

This species was occasionally found at Nahant, Massachusetts, in July, but has not been seen since it was studied by A. Agassiz. (See figs. 181 and 182.)

Stomobrachium (?) stauroglyphum.

Æquorea stauroglypha, Péron et Lesueur, 1809, Annal. du Mus. Hist. Nat., tome 14, p. 337.
Æquorea forbesiana, Gosse, 1853, Naturalist's Rambles Devonshire Coast, pp. 345, 348, plate 24.
Staurobrachium stauroglyphum, Haeckel, 1879, Syst. der Medusen, p. 225.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 486; *Ibid.*, 1905, tome 13, p. 147 (citation of literature to 1850).

The bell is hemispherical, about 40 to 70 mm. wide. 30 to 100 tentacles. Numerous lithocysts, each with 1 to 4 concretions, 30 to 70 radial-canals with linear bilamellar gonads on their mid-regions leaving short lengths of both ends free. Stomach as wide as the bell-radius. Very flat and shallow with 4 long, triangular lips with complexly folded margins. Medusa rose-red. English Channel. I am inclined to suspect that this may be merely an abnormal specimen of *Æquorea forskalea* with a 4-cornered mouth, due to a peculiar state of contraction or to an abnormal condition of growth.

Genus HALOPSIS A. Agassiz, 1863.

Halopsis, Agassiz, A., 1863, Proc. Boston Soc. Nat. Hist., vol. 9, p. 219; 1865, North Amer. Acal., p. 99, figs. 143–150.—Haeckel, 1879, Syst. der Medusen, p. 217.—Fewkes, 1888, Bull. Mus. Comp. Zool. at Harvard College, vol. 13, p. 233.
Non Halopsis cruciata, Agassiz, A., 1865, North Amer. Acal., p. 102.
Non Halopsis, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 57, taf. 6, figs. 3–6.

The genus *Halopsis* was founded by A. Agassiz, 1863, for *H. ocellata* of the New England coast, north of Cape Cod. "*Halopsis*" *cruciata* A. Agassiz belongs to the genus *Mitrocoma*, as does also "*Halopsis*" *megalotis* of Maas.

GENERIC CHARACTERS.

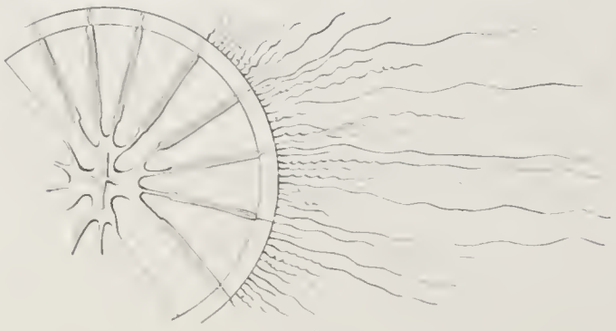
Æquoridæ with numerous radial-canals which arise from the periphery of the stomach in 4 radially situated groups or clusters. Stomach with 4 lips. There are numerous tentacles and marginal cirri. The lithocysts are of large size and each one contains a large number of concretions. The gonads are situated upon the radial-canals.

Halopsis ocellata A. Agassiz.

Halopsis ocellata, Agassiz, A., 1863, Proc. Boston Soc. Nat. Hist., vol. 9, p. 219; 1865, North American Acalephæ, p. 99, figs. 143, 150.—Haeckel, 1879, Syst. der Medusen, p. 217.—Fewkes, 1888, Bull. Mus. Comp. Zool. at Harvard College, vol. 13, No. 7, p. 233, plate 3, fig. 1 (young medusa).—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 51.

Adult medusa.—Bell about 70 mm. in diameter and about 4 times as broad as high. The gelatinous substance of the bell is not very thick. A large number of long tentacles, with hollow, conical, basal bulbs and about an equal number of short, slender, contractile cirri upon the bell-margin. 40 to 80 large lithocysts, 3 to 6 between each successive pair of radial-canals; each lithocyst contains 12 to 14 concretions arranged in two rows. Velum small. The radial-canals arise from the margin of the stomach in 4 radially situated clusters. There are usually 16 radial-canals, there being 3 to 5 canals in each cluster. These canals are straight, and the linear gonads are developed upon about three-quarters of their length. The stomach is cruciform and only about one-quarter as wide at the bell-diameter. The manubrium is short and there are 4 prominent radially situated lips. The medusa is colorless, with the exception of the gonads, which exhibit a slight grayish or pinkish tinge at the time of spawning.

Young medusa.—In the youngest medusa observed the bell was about 5 mm. in height and about twice as high as it was broad. There were only 4 radial tubes. There were 8 long tentacles with conical, hollow, basal bulbs and about 16 slender cirri. In addition to these there were about 12 lithocysts each containing 2 to 3 concretions. As development proceeds the bell becomes relatively flatter. The radial tubes increase in number, so that specimens of 25 mm. diameter have about 12 canals. The periphery of the stomach in these young medusæ is irregular in shape, but when the animal is about 50 to 60 mm. in diameter it becomes cross-shaped, the radial tubes arising from the ends of the arms of the cross. At about this time the genital organs develop upon the radial-canals. New radial tubes arise from the periphery of the stomach and extend downward toward the circular vessel.



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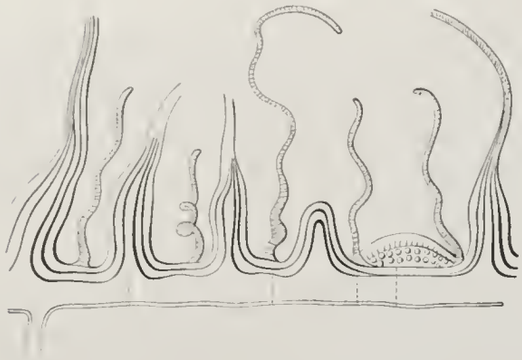

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FIGS. 183 and 184.—*Halopsis ocellata*, after A. Agassiz, in North American Acalephæ. 183, oral view; 184, bell-margin.

This rare medusa is occasionally found along the New England coast from Massachusetts Bay to Grand Manan, from July until September.

Genus ÆQUOREA Péron and Lesueur, 1809.

Medusa æquorea, FORSKÅL, 1775, Descript. animalium, p. 110; 1776, Icones rerum natural., plate 32.
Æquorea, PÉRON ET LESUEUR, 1809, Ann. Mus. Hist. Nat., tome 14, p. 336.—LAMARCK, 1816, Hist. Nat. Anim. sans Vert., tome 2, p. 498.
Æquorea+Mesonema, ESCHSCHOLTZ, 1829, Syst. der Acalephen, pp. 108, 112.—MAAS, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, pp. 40, 42.
Æquorea+Crematostoma+Mesonema+Rhegmatodes+Rhacostoma, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 359-361.
Æquorea+Rhegmatodes+Mesonema+Polycanna, HAECKEL, 1879, Syst. der Medusen, pp. 218, 221, 225, 229.
Æquorea, CLAUS, 1881, Arbeit. Zool. Inst. Wien, Bd. 3, p. 283; 1883, Untersuch. über Organisation und Entwick. der Medusen, p. 80.—BROWNE, 1903, Bergens Museums Aarbog, No. 4, p. 20.—BIGELOW, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 170.
Zygodactyla (*Campanulina*) (hydroid), HINCKS, 1868, Hist. British Hydroid Zooph., p. 191, plate 38, fig. 2.
Phorcynia, OKEN, 1815, Lehrbuch der Naturgesch., Theil 3, p. 121.

The type species is the highly variable *Æquorea forskalea* Péron et Lesueur, 1809, of the Mediterranean and Atlantic.

GENERIC CHARACTERS.

Æquoridæ with more than 8 simple, unbranched radial-canals which arise separately from the margin of the stomach and with more than 4 lips. Subumbrella smooth, without wart-like protuberances. Tentacles, lithocysts, and excretion papillæ numerous. Hydroid is *Campanulina*.

This genus is closely allied to *Zygodactyla*, but the surface of its subumbrella is smooth, whereas in *Zygodactyla* it is covered with interradial radiating lines of wart-like gelatinous papillæ which alternate in position with the radial-canals.

The lithocysts in *Æquorea* are closed vesicles on the subumbrella margin of the velum, and the concretions are of ectodermal origin. A conical excretion pore is commonly found on the inner (subumbrella) side of each tentacle-bulb adjacent to the ring-canal. Ocelli are unknown.

Medusæ of *Æquorea* commonly display great individual color variability, ranging through deep-blue, violet, milky, or transparent, and in their ontogeny they are also quite variable

Plate 42.

Fig. 1. *Æquorea forskalea*, natural size. Tortugas, Florida, May 8, 1906.

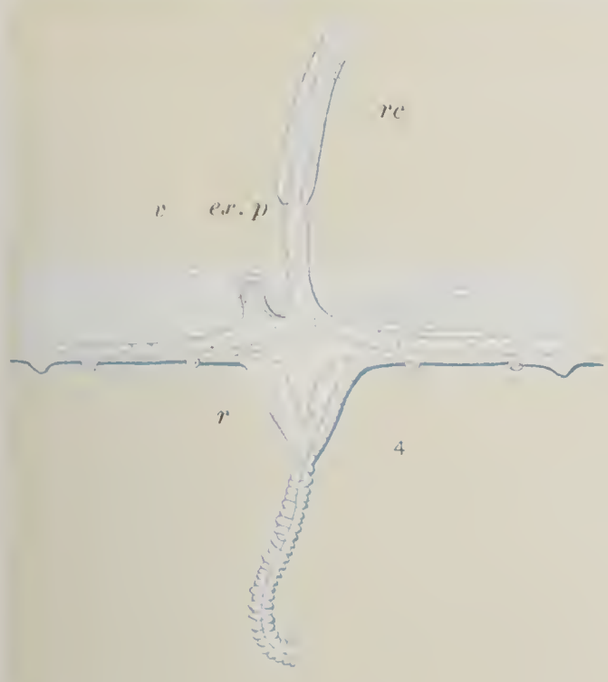
Fig. 2. *Æquorea forskalea.* An enlarged view of the bell-margin, showing radial-canals, female gonads, tentacles, lithocysts, and excretory pores.

Fig. 3. *Æquorea forskalea.* Two of the marginal lithocysts.

Fig. 4. *Æquorea forskalea.* Portion of the bell-margin seen from the exumbrella side, showing a radial-canal, *rc;* the ring-canal, *r;* an excretory pore, *ex p;* and the velum, *v.*

Figs. 5 and 6. *Æquorea* (variety of *forskalea*?). Figure 6, part of the bell-margin of the medusa shown in figure 5. Key West, Florida, June 7, 1897.

Drawn from life, by the author.



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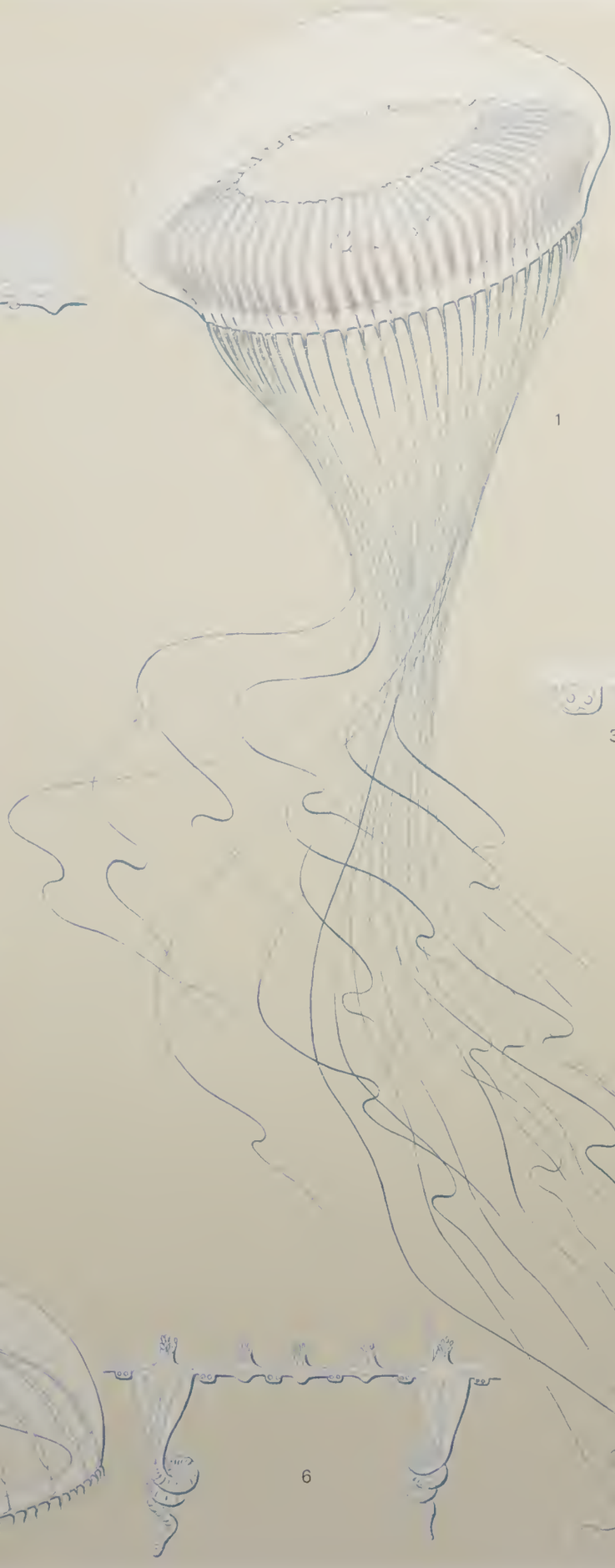

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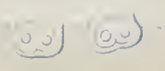

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from the meristic standpoint, some individuals having the tentacles more and others less numerous than the radial-canals. Moreover, the shape of the stomach changes from a simple 4-lipped manubrium to one having 50 or 100 lips, widely gaping, and with curtain-like, folded margins. Gonads develop at various times upon the radial-canals. Indeed the greatest confusion has been introduced into the synonymy through the description of developmental stages of *Æquorea* under various generic names.

For example, Haeckel distinguishes:

(1) *Rhegmatodes*, with simple funnel-shaped stomach and closed, narrow-necked mouth.
(2) *Polycanna*, with elongate stomach with large throat-tube and closed mouth with folded lips.
(3) *Æquorea*, with wide, short stomach and widely gaping mouth with simple lips.
(4) *Mesonema*, with wide, short stomach and widely gaping mouth with complexly folded lips.

Claus, 1881, 1883, shows that the common *Æquorea forskalea* of the Atlantic and Mediterranean passes from the "*Rhegmatodes*" condition through all four stages, ending with the "*Mesonema*" stage, and there can be no doubt but that Haeckel has described this medusa in its various stages under different generic names. Indeed, as Browne, 1903, and Bigelow, 1909, have shown, when an *Æquorea* (Haeckel) contracts its stomach-wall so as to tend to close its mouth and cause its lips to fold complexly, it becomes a "*Polycanna*" or a "*Mesonema*."

When young the lips are commonly closed, but when old the mouth is often found to be gaping open; while in an intermediate condition of life the mouth is open when relaxed and closed when contracted. It is evidently impossible to separate genera upon intergrading characters such as these, and we have no alternative but to include all Æquoridæ with numerous simple radial-canals, numerous lips, and smooth subumbrella under the genus *Æquorea*, allowing the relative numbers of radial-canals and lips, or of canals and tentacles, to serve as specific distinctions.

The following species appear to me to be too vaguely described for recognition, and I have therefore failed to consider them:

Æquorea ciliata Eschscholtz, 1829, Syst. der Acal., p. 109, taf. 9, fig. 1. From Pacific coast of America between 41° to 50° N. lat.

Mesonema abbreviata Eschscholtz, 1829, *loc. cit.*, p. 113, taf. 11, fig. 3. From the Straits of Sunda.

Mesonema dubium Brandt, 1838, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 6, tome 4, p. 361, plate 26. From off the coast of Japan.

Æquorea cubana = *Zygodactyla cubana* Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 60, plate 25, figs. 84, 85. (Too immature for determination.) From Tortugas, Florida.

Æquorea forskalea Péron and Lesueur.

Plate 42, figs. 1 to 6; plate 43, fig. 8.

SYNONYMS OF THE EUROPEAN MEDUSA.

Medusa æquorea, Forskål, 1775, Descriptiones animalium, Hauniæ, p. 110; 1776, Icones rerum naturalium, plate 32.
Medusa patina, Modeer, 1791, Nova Acta Phys. Med. Acad. Caes. Leop. Carol., tome 8, Appendix, p. 32.
Æquorea forskalea, Péron et Lesueur, 1809, Ann. Mus. Hist. Nat., tome 14, p. 336.—Delle Chiaje, S., 1841, Animali senza Vert., tome 7, tav. 148, fig. 7; also, *Æ. rissoana*, tav. 139.—Forbes, 1851, Proc. Zool. Soc. London, p. 272, plate 4.—Krukenberg, 1880, Vergleichend. physiolog. Studien zu Tunis, etc., Abth. 3, p. 124 (reactions to curare and strychnine).—Claus, 1881, Arbeit. Zool. Inst. Wien, Bd. 3, p. 283; *Ibid.*, Bd. 4, p. 90; 1882, Zool. Anzeiger, Bd. 5, p. 284 (development of the egg); 1883, Untersuch. über Organisation und Entwick. der Medusen, p. 61, taf. 16–20, fign. 112–157 (variations and development).—Haeckfr, 1892, Archiv. Mikr. Anat., Bd. 40, p. 243, taf. 13, 14, 5 fign. (development of the egg); 1895, *Ibid.*, Bd. 45, p. 200.—Hartlaub, 1894, Wissen. Meeresuntersuch. Komm. Meere Kiel, Helgoland, Neue Folge, Bd. 1, p. 196 = *Polycanna germanica*, of Haeckel.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 482; *Ibid.*, 1905, tome 13, p. 130 (citation of references to 1850).—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 24, planche 2, figs. 12–14 (states of contraction of the stomach walls).
Æquorea risso, Lamouroux, Bory de St. Vincent et Deslongchamps, 1824, Hist. Nat. Zoophs., Paris, p. 372.
Æquorea rissoana, Risso, 1826, Hist. Nat. Nice et Alpes maritimes, p. 294, planche 7, figs. 37, 38.
Æquorea violacea, Milne-Edwards, 1841, Annal. des Sci. Nat., Zool., sér. 2, tome 16, p. 195, planche 1.
Æquorea vitrina, Gosse, 1853, Naturalist's Rambles Devonshire Coast, p. 340, plate 23.
Zygodactyla vitrina (hydroid), Hincks, 1868, Hist. British Hydroid Zooph., p. 192, plate 38, figs. 2–2*b*.
Zygodactyla rosea, Metschnikoff, E., 1871, Verhandl. Gesell. Freunde Nat. Moskau, Bd. 8, p. 353, taf. 5, fign. 7, 8
Octocanna octonema (young medusa ?) + *Æquorea discus* + *Æ. forskalea* + *Æ. violacea* + *Mesonema eurystoma* + *Polycanna fungia* + *P. germanica* + *P. italica* + *P. vitrina*, Haeckel, 1879, Syst. der Medusen, pp. 213 219, 220, 227, 229–231.

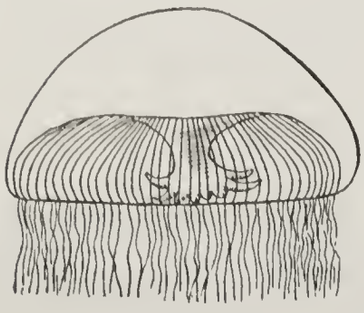
Æquorea violacea, Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 359.
Æquorea forskalii, Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, p. 23 (egg), 34 (segmentation), 54 (formation of entoderm); 1886, Arbeit. Zool. Inst. Wien, p. 262.
Mesonema bairdii, Fewkes, 1886, Report U. S. Fish Commission for 1884, p. 962.
Polycanna forskalea, Browne, 1897, Proc. Zool. Soc. London, p. 828.
Æquorea forskalea + *Æ. norvegica* + *Æ. vitrina*, Browne, 1903, Bergens Museums Aarbog, No. 4, pp. 20, 21.
Staurobrachium staurоglyphum (abnormal medusa with a 4-cornered mouth ?), Haeckel, 1879, Syst. der Medusen, p. 225.
(?) *Polycanna rissoana*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 24, planche 6, fig. 44.

SYNONYMS OF MEDUSÆ FROM AMERICAN ATLANTIC WATERS.

Zygodactyla cyanea, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Agassiz, A., 1865, North Amer. Acal., p. 107, fig. 159. Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 60, plate 11, figs. 23, 23*a*; plate 15, figs. 33, 34; 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, p. 17, plate 3, figs. 26, 27.
Mesonema cyanea, Haeckel, 1879, Syst. der Medusen, p. 227.
Polycanna americana, Fewkes, 1889, Report U. S. Commiss. Fish and Fisheries for 1886, p. 523.
Rhacostoma dispar (injured and regenerating medusa), Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 61, plate 13, figs. 27–29.
(?) *Crematostoma flava*, Agassiz, A., 1865, North American Acalephæ, p. 108, fig. 159*a*.

MEDUSÆ FROM THE PACIFIC WHICH MAY POSSIBLY PROVE TO BE IDENTICAL WITH Æ. FORSKALEA.

(?) *Æquorea euthodina*, Péron et Lesueur, 1809, Annal. du Mus. Hist. Nat., tome 14, p. 336.—Haeckel, 1879, Syst. der Medusen, p. 220.
(?) *Æquorea cyanea*, de Blainville, 1834, Man. Actinologie, p. 277, plate 32, fig. 2.
(??) *Zygodactyla* (*Mesonema*) *cærulescens*, Brandt, 1838, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. 6, Sci. Math. et Nat., tome 4, p. 360, plate 5.
(?) *Æquorea cærulescens*, Torrey, 1909, University California Publications, Zool., vol. 6, p. 28.



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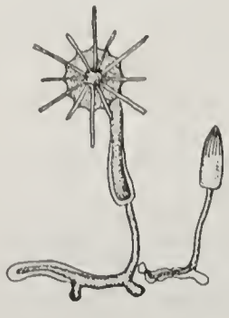

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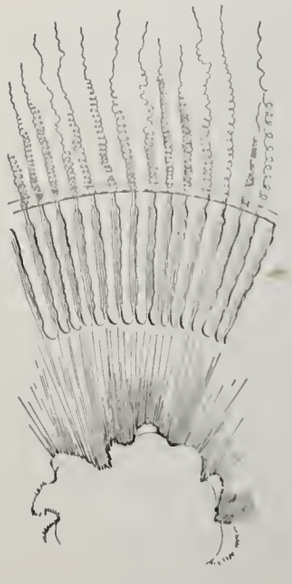

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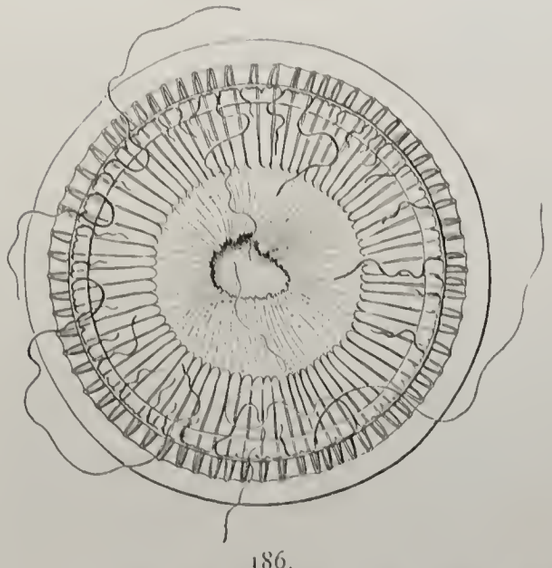

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Fig. 185.—Hydroid and medusa of "*Zygodactyla vitrina*," after Hincks, in British Hydroid Zoophytes. This is probably *Æquorea forskalea*.
Fig. 186.—*Æquorea forskalea*, from preserved specimen collected by Dr. Lobianco in the Bay of Naples. Drawn by the author.
Fig. 187.—"*Zygodactyla cyanea*," after A. Agassiz, in North American Acalephæ. This is probably *Æquorea forskalea*.

This medusa has been studied most carefully by Claus, 1881, 1883, and Browne, 1897. It is highly variable both in form and color, and Claus has given reason for the belief that Haeckel's *Æquorea discus*, *Æ. violacea*, *Æ. forskalea*, *Polycanna fungia*, *P. germanica*, *P. italica*, *P. vitrina*, and *Mesonema enrystoma* are only stages in the growth of or local or color varieties of *Æquorea forskalea*. *Octocanna* represents the youngest and *Mesonema*

the oldest stage in Haeckel's "System," *Æquorea* and *Polycanna* being intermediate stages. I have tabulated Haeckel's description of these forms and present it herewith. If these forms be actually one and the same species, it appears that the stomach ranges in width from two-thirds to four-thirds as wide as the bell-radius, and from a mere short cylinder with vertical walls and mouth widely gaping, to a conical form with elongate cylindrical throat-tube and tightly closed mouth. The tentacles may be as short as the bell-radius or very long, possibly dependent upon their state of contraction, and may range from 50 to 300 in number. The lithocysts range from being less numerous than the tentacles to 10 times as numerous as the latter.

Varieties of Æquorea forskalea, from Haeckel's Descriptions.

	Æquorea discus Haeckel, 1879.	Æquorea violacea Milne-Edwards, 1841.	Æquorea forskalea, according to Haeckel, 1879.	Polycanna fungia Haeckel, 1879.
Size of bell in mm.	100 to 125 wide, 20 to 25 high.	70 wide, 10 high.	200 to 400 wide, 40 to 50 high.	150 wide, 50 high.
Shape and size of stomach. Size in terms of bell-radius (*r*).	Shallow, with open mouth, two-thirds *r* wide.	Shallow, with open mouth, two-thirds *r* wide.	As in Æ. violacea.	Four-thirds *r* wide; conical, with long cylindrical throat-tube and 32 large lancet-shaped lips.
Number of tentacles.	50 to 80 very long.	60 to 80 short.	100 to 200	80 to 100 very long.
Number of lithocysts and concretions.	500 to 800, each with 2 to 4 concretions.	200 to 300, each with 2, occasionally 3, concretions.	?	400 to 600, each with 4 concretions.
Number of radial-canals.	100 to 160	60 to 80	100 to 200	160 to 200
Number of gonads.	Bilamellar, on each and every radial-canal.	Bilamellar, as in Æ. "discus."	Bilamellar, as in Æ. discus and Æ. violacea.	Linear, folded, 80 to 100 on alternate canals.
Color.	?	Gonads, tentacles, and bell-margin violet.	Gonads brown. Gastric canals gray.	Colorless.
Where found.	Messina, Mediterranean.	Mediterranean.	Mediterranean.	Southwestern coast of Norway.

	Polycanna germanica Haeckel, 1879.	Polycanna italica Haeckel, 1879.	Polycanna vitrina = Æquorea vitrina Gosse, 1853.	Mesonema eurystoma Haeckel, 1879.
Size of bell in mm.	60 to 80 wide, 30 to 40 high.	80 to 90 wide, 20 to 22 high.	40 to 60 wide, 20 to 30 high.	60 to 80 wide, 15 to 20 high.
Shape and size of stomach. Size in terms of bell-radius (*r*).	As in P. fungia, but flatter and with 50 to 70 lips.	Two-thirds *r* wide; flat, with a long cylindrical mouth-tube and 50 to 60 small crinkled lips.	1 *r* wide; funnel-shaped, 20 to 50 lips.	Two-thirds *r* wide; shallow, with widely gaping mouth.
Number of tentacles.	50 to 70 very long.	50 to 60 long.	200 to 300 short.	60 to 80 short.
Number of lithocysts and concretions.	200 to 400, each with 4 concretions.	100 to 200, each with 2 concretions.	80 to 100, each with 2 to 3 concretions.	300 to 500, each with 2 to 4 concretions.
Number of radial-canals.	50 to 70	50 to 60	80 to 100	60 to 80
Number of gonads.	Linear, 50 to 70.	Linear, bilamellar, 50 to 60.	Linear, irregularly knotted, 80 to 100.	Linear, bilamellar, 60 to 80.
Color.	Colorless.	Lips and gonads rose-red. Bell with reddish hue.	Stomach, gonads, and mouth milky-white.	Colorless.
Where found.	German Ocean, Helgoland.	Mediterranean.	British coasts.	Adriatic, Mediterranean.

The gonads may be bilamellar or linear, or linear with swollen, knot-like intervals. The color ranges through blue, gray, brown, rose-red, violet, milky-white, or colorless. Haeckel's specimens were from the Mediterranean and Atlantic coasts of Europe. Making all due allowance for the description of growth-stages and of regenerating or injured specimens, it is evident that we here have a medusa which appears to be as variable as *Aurelia* among the Scyphomedusæ.

The bell is usually somewhat flatter than a hemisphere, with thick, gelatinous center, thinning out to a sharp-edged margin. The center of the bell is often biconvex. The largest of 28 specimens obtained by Claus, 1883, in the Mediterranean, were about 150 mm. wide, had 67 radial-canals, 66 lips, 111 tentacles, 300 to 400 lithocysts, and his specimens ranged in color from blue or light-rose to colorless.

When the medusa is 1.5 mm. wide there are 4 well-developed radial and 4 small interradial tentacles, 8 adradial lithocysts, and no gonads. The gonads begin to develop upon the radial-canals of the three oldest orders when the medusa is about 35 to 60 mm. wide. They are, however, very irregular in development and may appear equally developed and all small when there are 70 radial-canals and the medusa is 100 mm. wide; or the gonads may be developed on only 32 (half) of the 65 radial-canals when the medusa is 75 mm. wide. Usually a few canals fail to develop gonads. A thickening of the gonads along the edges of the radial-canals gives a bilamellar aspect to the gonads, whereas in a less vigorously developed state they appear to be merely linear, or linear with knot-like swellings at intervals.

There are conical, excretory papillæ at the bases of the tentacles on the subumbrella side, above the velum.

Browne, 1903, calls attention to certain varieties in shape of the tentacle-bulbs of specimens of *Æquorea*, but I can not feel convinced that some, or possibly all, of these differences may not be due to states of development or of contraction.

In 1897 Browne gives the following data from a study of 5 specimens of *Æquorea forskalea* from Valencia Harbor off the southern coast of Ireland:

Width of bell.	Width and shape of stomach.	Number of radial-canals.	Number of lips.	Number of tentacles.	Number of lithocysts.	Gonads.
mm.	*mm.*					
25	13 at base, 7 wide at mouth.	140 leave the stomach, only 45 reach the ring-canal.	55	7 large, about 100 mere bulbs.	About 200.	A few beginning to develop.
30	?	114; about half reach the ring-canal.	?	8 large, 100+ small.	About 200.	?
55	26 wide.	145; nearly all unite with the ring-canal.	?	16 well-developed. 100+ small.	About 200.	Conspicuous.
60	33 wide, with mouth 17 wide.	180 complete.	?	28 well-developed. 40 bulbs.	?	Well developed.
135	55	153 complete.	?	43 well-developed. 120 bulbs.	About 300 to 400.	Well developed.
160	53	88 complete.	?	56 well-developed, and 150+ bulbs.	About 300 to 400.	Well developed.

The development has been studied by Wright (Journal Microscop. Science, London, New Series, vol. 3, p. 45, plate 4, figs. 1–6), who reared the hydroid from the egg of the medusa.

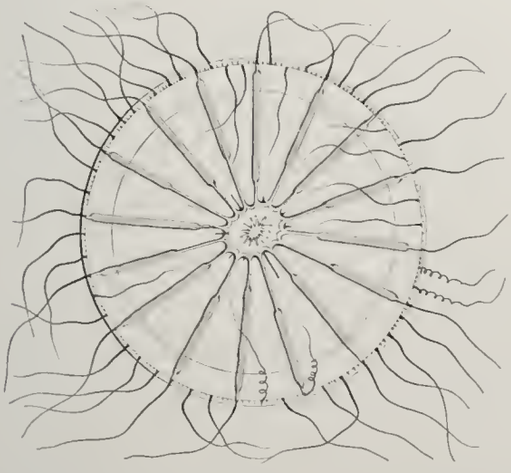
The early stages of development of the egg have been studied by Claus, Metschnikoff, and Haecker. The sexual products are cast out near sunrise, in March and April, in the Mediterranean. The males are more bluish and the females more rose-colored in their sexual organs. The egg is 0.16 mm. wide. Segmentation is total but not equal, the oval blastula having small cells at the animal and large spindle-shaped cells at the vegetative pole. The entoderm is formed by ingression of cells from the narrow, posterior end of the larva.

Haecker gives details of the process of maturation of the egg. The nucleolus is cast out into the cytoplasm and degenerates.

The hydroid is very minute and is apparently a *Campanulina*. The smooth-stemmed polypites arise singly (or branched ?) from a creeping hydrorhiza. The hydrothecæ are cylindrical, truncated squarely below, and the orifice is armed with many convergent segments. The polypites have 12 alternating tentacles, which are united for about one-third of their length by a basal web. The gonangia are unknown.

This medusa appears to be widely distributed, being found in the Mediterranean and off the Atlantic coasts of Europe northward to the Arctic coast of Norway. It is clearly identical with *Zygodactyla cyanea* Agassiz, which is very abundant at Tortugas, Florida. The medusa may be colorless, milky, blue, or violet, and is very variable in the order of appearance and development of radial-canals, tentacles, stomach, and gonads. *Polycanna americana* Fewkes, from the Gulf Stream off the coast of the United States, is apparently identical with *Æquorea forskalea*.

In the Pacific *Æquorea eurhodina* Péron and Lesueur from Bass Straits, Australia, appears to be closely related to, if not identical with, *Æ. forskalea;* but its true relationship can not be determined from the meager account given by Péron and Lesueur. The same statements apply also to *Æquorea cyanea* from off the coast of New Guinea.



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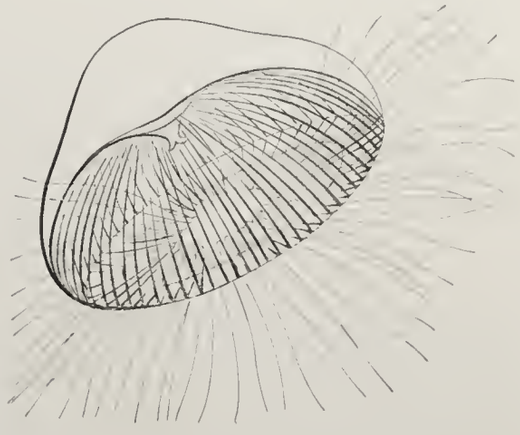

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Fig. 188.—*Æquorea floridana*, after A. Agassiz, in North American Acalephæ.
Fig. 189.—*Æquorea albida*, from A. Agassiz, in North American Acalephæ.

Æquorea cærulescens (*Zygodactyla cærulescens* Brandt) from off the coast of Japan may possibly be identical with *Æ. forskalea*.

Bigelow (1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 177, plates 4 and 35), records two specimens of *Æ. cærulescens* from the eastern tropical Pacific, one being 12 and the other 60 mm. in diameter. The tentacles are not arranged in two rows as figured by Brandt. Bigelow's large specimen had 94 radial-canals, about 450 tentacles with elongated, compressed, conical basal bulbs and numerous, rudimentary, marginal knobs and lithocysts. Stomach half as wide as the bell-diameter. 31 lips. Tentacle-bulbs deep bluish-black.

I believe that *Æ. norvegica* Browne is probably identical with *Æquorea forskalea*. Browne's description of *Æquorea "norvegica"* is as follows:

Bell flat, 90 mm. wide. About 200 tentacles with long, laterally compressed, tapering, basal bulbs. Small marginal bulbs, some with a minute tentacle, alternate with the thickly crowded, long tentacles. 1 to 2 lithocysts between every tentacle and marginal bulb. Excretory papillæ (?) at the bases of the tentacles, on the subumbrella above the ring-canal. 98 radial-canals. Stomach flat, half as wide as the bell and quite shallow. 46 long lips with fimbriated edges. Bilaminate, linear gonads on all 98 radial-canals, from near the stomach to near the ring-canal. Transparent, gonads white or gray. Lofoten Islands, Arctic Ocean, January. One specimen.

Æquorea "victoria" Maas = Æ. forskalea?

Mesonema victoria, Murbach and Shearer, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 72; 1903, Proc. Zool. Soc. London, vol. 2, p. 180, plate 19, figs. 1–2; plate 22, fig. 2.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 174.
Æquorea victoria, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 43.

Bell hemispherical, 70 mm. wide. More than 100 tentacles and numerous small marginal papillæ. Lithocysts and excretory papillæ are present. No ocelli. Peduncle hemispherical. Mouth lobed. Lobes serrated and as numerous as the radial-canals. About 100 radial-canals, each covered on its outer surface by a ridge of glandular cells. Gonads and bell-margin white, with a slight trace of blue in the large tentacles. Victoria Harbor, Puget Sound. Esquimalt Harbor. North Pacific coast of North America.

I can not distinguish this medusa from *Æquorea forskalea* of the Atlantic and Mediterranean. Were it described from the Atlantic I would not hesitate to designate it *Æ. forskalea*. As Bigelow, 1909, states it is probably identical with *Zygodactyla flava* A. Agassiz, 1865.

Æquorea maldivensis Browne.

Æquorea maldivensis, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 732, plate 56, figs. 4–12.

Bell 75 mm. high, flatter than a hemisphere, with thick walls. 30 to 50 tentacles with large basal bulbs and excretory pores. 2 to 4 marginal bulbs between each successive pair of tentacles. Numerous small lithocysts, 15 to 20 between each successive pair of tentacles. 50 to 70 straight, simple radial-canals with gonads occupying nearly their entire lengths. Stomach with circular outline, about half as wide as the bell. Lips small, about as numerous as the radial-canals. Mouth capable of closing. Maldive Islands, Indian Ocean, Haddumati Atoll. It may be identical with *Æquorea forskalea* or *Æ. macrodactyla*. (See pages 325 and 333.)

Æquorea floridana Mayer.

Plate 43, figs. 6 and 7.

Rhegmatodes floridanus, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Agassiz, A., 1865, North Amer. Acal., p. 67, fig. 139.
Æquorea floridana, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 61.
Rhegmatodes floridana, Haeckel, 1879, Syst. der Medusen, p. 223.

The bell is about 30 to 50 mm. in diameter, flatter than a hemisphere, and the gelatinous substance is thick at the center, with a low, dome-like apex, but it becomes thinner as one approaches the margin. 80 to 100 very small, slender tentacles with tapering, hollow basal bulbs; the tentacles about one-seventh to one-half as long as bell-radius and about 4 times as numerous as radial-canals. Just above each tentacle-bulb is a hollow, spur-like papilla, with a blunt extremity covered with nematocysts. There are also about 3 tentacle rudiments with papillæ between each successive pair of tentacles (plate 43, fig. 7). The very minute lithocysts are also about 4 times as numerous as the tentacles and each one contains 2 spherical concretions; they are situated at the sides of the tentacle-bulbs and between the rudimentary bulbs on the margin. Velum is narrow. 16 to 24 extremely narrow radial-canals, which arise separately and at equal intervals from the edge of the stomach and extend straight out to the circular vessel. The narrow linear gonads are developed upon these canals and do not extend to the circular vessel. They are widest at a point about the velum's width above the circular vessel and gradually taper inward toward the edge of the stomach. Stomach very small, about one-seventh as wide as bell-diameter and about one-fifth as high as wide. Mouth widely open, surrounded by small crenulated lips which are as numerous as the radial-canals. The stomach is a delicate turquoise, all the other parts being colorless. (See fig. 188.)

This form may be at once distinguished by its minute tentacles and very slender, thread-like radial-canals. It is found at Key West and Tortugas, Florida, in April to June. It is extremely languid in its movements and is commonly found floating near the surface on calm days. It is possibly only a variety of *Æquorea forskalea*, but I have never found intergrading forms.

Plate 43.

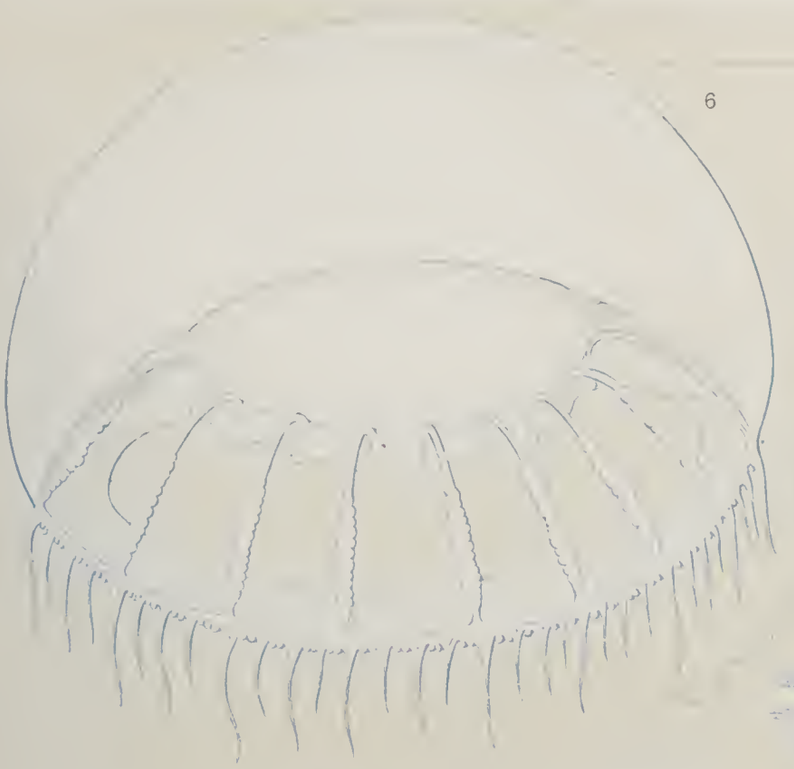
Figs. 1 to 4. *Æquorea albida.* Successive stages in the development of the young medusa. Agassiz Laboratory, Newport, Rhode Island, June to September, 1892, 1893, 1896.

Fig. 5. *Æquorea albida.* A part of the bell-margin of the medusa shown in figure 4.

Figs. 6 and 7. *Æquorea floridana.* Key West, Florida, April 14, 1905. Figure 7, a part of the bell-margin.

Fig. 8. *Æquorea forskalea*, young medusa. North Eleuthra Island, Bahama Islands, March 7, 1893.

Drawn from life, by the author.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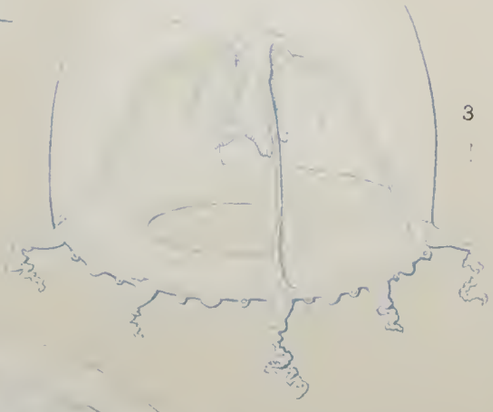
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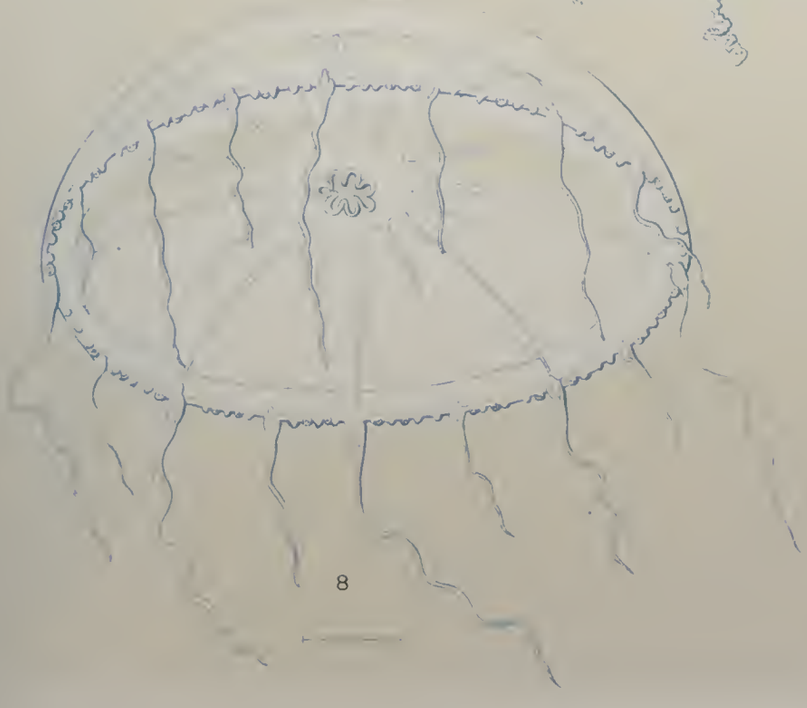
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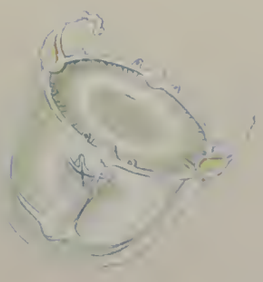
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Æquorea albida A. Agassiz.

Plate 43, figs. 1–5; plate 44, fig. 5.

Æquorea albida, Agassiz, A., 1862, in L. Agassiz's Cont. Nat. Hist. U. S., vol. 4, p. 359; 1865, North Amer. Acal., p. 110, figs. 160–162.—Haeckel, 1879, Syst. der Medusen, p. 221.—Verrill, 1873, Report Com. Fish and Fisheries U. S., for 1871–72, p. 729.

This medusa is, I believe, only a well-marked northern variety of *Æquorea forskalea*, but it may be distinguished by its color, the entodermal lamella of the bell being a decided green and the tentacle-bulbs often orange with black-colored granules. Such colors are not recorded in *Æquorea forskalea*.

Bell about 60 mm. wide, somewhat miter-shaped, with flaring sides, slightly higher than a hemisphere. About 300 slender tentacles, longer than bell-diameter and with well-developed basal bulbs which contain excretion papillæ. The lithocysts are about twice as numerous as the tentacles and each lithocyst contains 2 to 4 spherical concretions. Velum is well developed. There are 80 to 100 simple, straight radial-canals and a narrow, circular tube. Stomach is wide and shallow, its diameter being about one-third that of the bell. The throat-tube is short and conical and the mouth-opening is surrounded by small lappets which are as numerous as the tentacles. The gonads are linear and are developed upon nearly the entire lengths of the radial-canals, leaving both ends free. The gelatinous substance of the bell exhibits a slight bluish tinge. The entodermal lamella is of a decided green. The entoderm of the stomach, gonads, and tentacle-bulbs is milky or cream-colored. In some individuals the entoderm of the tentacle-bulbs is of a decided orange and contains black granules. (See fig. 189.)

Young medusa (plate 43, fig. 1).—The youngest medusa observed was 0.75 mm. in diameter. There were only 4 tentacles. 2 of these were quite long and possessed well-developed

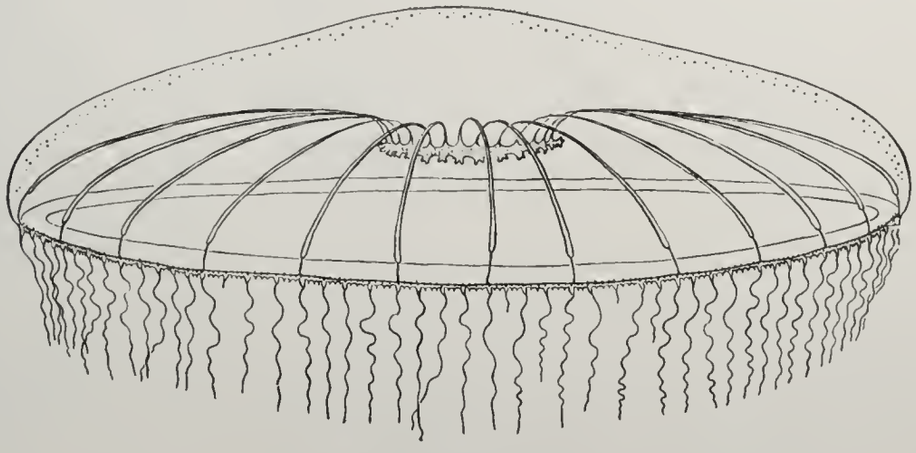


Fig. 190.—*Æquorea tenuis*, by the author, from a medusa from Woods Hole, Massachusetts, Sept., 1907.

basal bulbs, and the other 2 were rudimentary. There were 8 lithocysts, each containing a single concretion. These were situated upon the bell-margin, very near to the bases of the tentacles. The velum was large. There were 4 radial-canals and the manubrium was a simple tube with 4 cruciform lips.

As development proceeds the tentacles increase in number, and closely following them the radial tubes grow downward from the margin of the stomach to the circular canal. The lips increase in number much more slowly than do the radial-canals. The gonads and excretion papillæ do not make their appearance until after the medusa has acquired 16 radial-canals. A. Agassiz succeeded in rearing the egg of this species and it developed into a small hydroid 1.25 mm. in height and provided with 12 long, straight tentacles.

This form is common along the New England coast of the United States from June until October. It has not been taken either at Beaufort, North Carolina, nor at Charleston, South Carolina, and is probably confined to northern waters.

Æquorea tenuis.

Rhegmatodes tenuis, A. Agassiz in L. Agassiz's, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 361.—Agassiz, A., 1865, North Amer. Acal., p. 95, figs. 136-138.—Verrill, 1873, Report Commiss. Fish and Fisheries for 1871-72, pp. 454, 729.—Haeckel, 1879, Syst. der Medusen, p. 223.—Hargitt, 1901, American Naturalist, vol. 35, p. 591, 58; *Ibid.*, 1902, vol. 36, p. 553; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 51, 1 fig.; 1905, Biological Bulletin Marine Lab. Woods Hole, vol. 9, p. 368, 14 figs. in text (variations).—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 383, fig. 105, A, B.

Adult medusa.—Bell 80 to 100 mm. in diameter and 3 or 4 times as broad as high. Gelatinous substance thick at apical pole, gradually becoming thinner approaching the margin. Cavity of subumbrella shallow. 48 to 90 long, slender tentacles, which are about twice or three times as numerous as the radial-canals. The long tentacles have large, conical, hollow bases. Besides these long tentacles, there are about 200 to 250 small rudimentary tentacles. Excretion papillæ, or "spurs," are found at the bases of most of the large tentacles upon the subumbrella side of the circular canal. 48 to 90 lithocysts, each containing 2 concretions. Velum well developed. About 24 to 32 long, straight radial-canals extend from periphery of stomach to circular canal. Stomach flat and funnel-shaped, about one-fifth as wide as diameter of bell. The mouth is a small opening surrounded by very minute lappets or folds. The gonads are linear and are situated upon nearly the whole length of radial-canals, not quite reaching the circular canal.

Fig. 191.—*Æquorea tenuis*, after A. Agassiz, in North American Acalephæ. Oral view, natural size.

This species is abundant in Buzzard's Bay, Massachusetts, and in the eastern part of Long Island Sound in September, but it is far commoner in some years than in others.

Young specimens of a diameter of 40 to 50 mm. have 16 to 24 radial tubes.

Hargitt, 1905, describes and figures many departures of this medusa from the normal, and finds that the radial-canals, gonads, and lithocysts are all very variable both in form, number, and position. The radial-canals often display anastomoses, forkings, and loops, as in other species of *Æquorea*.

Æquorea globosa Eschscholtz.

Æquorea globosa, Eschscholtz, 1829, Syst. der Acal., p. 110, taf. 10, fig. 2.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 43, taf. 8, fign. 48-50.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 173.
Rhegmatodes globosa, Haeckel, 1879, Syst. der Medusen, p. 222.

The disk is about 20 to 40 mm. wide and the gelatinous substance is very thick, so that the exumbrella is almost hemispherical, or higher, with bulging sides; while the subumbrella is almost flat and the bell-cavity very shallow. There are about 50 tentacles, 50 radial-canals, and the same number of lips. The stomach is about half as wide as the diameter of the disk. The well-developed tentacles are slender, tapering, and less than bell-radius in length. They have large basal bulbs which are urn-shaped, being wider below than at bell-margin. The lithocysts and tentacle rudiments are each about twice as numerous as the tentacles and are quite regularly spaced around the margin. Velum narrow. Radial-canals straight, simple, and narrow. The stomach lacks a peduncle and the lips are pointed and may close the oral opening. The thin, linear gonads are developed upon almost the entire lengths of both sides of each radial-canal. Gonads and radial-canals greenish-gray.

This medusa is found in the tropical Pacific. It is best described by Maas, 1905, from the Malay Archipelago. Maas gives the following data for 4 specimens found by the *Siboga* expedition in the Malay Archipelago, at Kabaëna, and Salomakië:

Diameter of disk.	Diameter of stomach.	No. of tentacles.	No. of radial-canals.	No. of lips.	Condition of gonads.
mm.	*mm.*				
12	6	48	48	48(?)	Present.
14	6	45	44	40+	All well developed.
20	9	49	49	40+	All well developed.
20	9	48	48	48	Well developed.

Æquorea macrodactyla Bigelow.

Mesonema macrodactyla, Brandt, 1834, Recueil Actes séances publiques Acad. St. Pétersbourg, p. 21 of the "separate."
Mesonema macrodactylum, Brandt, 1838, Mém. Acad. St. Pétersbourg, sér. 6, tome 4, Sci. Nat., p. 359, taf. 4.—Haeckel, 1879, Syst. der Medusen, p. 226.—Goette, 1886, Sitzungsber. Akad. Wissen. Berlin, p. 833.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 40, taf. 8, fign. 51, 54; 1906, Revue Suisse de Zool., tome 14, p. 96.—Chun, 1896, Mitt. Nat. Mus. Hamburg, Jahrg. 13, p. 7.—Bedot, 1905, Revue Suisse de Zool., tome 13, p. 139 (literature 1834–50).
Æquorea macrodactylum, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 174, plate 36.

In common with other allied forms this medusa is very variable.

The disk is a thick biconvex lens 20 to 45 mm., or more, wide. There are 10 to 30 tentacles at the ends of some of the radial-canals. These tentacles are elongate, tapering, with large, swollen, hollow basal bulbs. They are longer than the bell-diameter when expanded and their basal bulbs are provided with excretory pores. There are 3 to 4 times as many rudimentary tentacle-bulbs as tentacles; these are somewhat irregularly distributed around the bell-margin. The lithocysts are more numerous than the tentacular rudiments and are very small. Number of concretions (?) There are 60 to 100, or more, straight, simple radial-canals. The stomach is very shallow and about half as wide as the disk, with 20 to 40 lips. Gonads linear and developed on both sides of each radial-canal, leaving both ends of the canals free; they begin to develop when the medusa is about 25 mm. wide and then they often appear only on the older and wider canals, leaving the newly formed, narrow radial-canals free of gonads until a later period.

Entoderm of lips, radial-canals, and tentacle-bulbs milky in color, all other parts colorless.

Widely distributed over the tropical Pacific, being found by Goette and Chun off the east coast of Africa, by Maas in the Malay Archipelago, and by Agassiz and Mayer among the Marshall Islands. The species has been most carefully studied by Maas, 1905, who presents a table exhibiting its range of variation and also a good figure of the mature medusa.

Bigelow, 1909, found 11 specimens of this medusa in the eastern tropical Pacific, and states that when seen from without, the tentacle-bulbs are broadly triangular and extend in a somewhat triangular or spur-like process up over the exumbrella surface of the bell. The stomach-wall is of considerable breadth, but the mouth is apparently not capable of closing.

Bigelow shows good reasons for believing that *Æquorea maldivensis* Browne is identical with *Æ. macrodactyla.* (See page 330.)

Æquorea pensilis.

Medusa sp. Forskal, 1776, Icones rerum naturalium, p. 9, tab. 28, fig. B.
Medusa cœlum pensile, Modeer, 1791, Nova Acta Phys. Med., L. C. 8, App., p. 32, No. 32.
Æquorea mesonema, Péron et Lesueur, 1809, Tableau Meduses, p. 336, No. 21.
Mesonema cœlum pensile, Eschscholtz, 1829, Syst. der Acal., p. 112.
Mesonema pensile, Haeckel, 1879, Syst. der Medusen, p. 226.—Browne, 1904, Fauna Geog. Maldive and Laccadive Archipelago, vol. 2, p. 733, plate 55, fig. 4; plate 57, figs. 2–9; 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Supplementary Report No. 27, p. 147, plate 2, figs. 11–15.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 42, taf. 8, fig. 52.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 484; *Ibid.*, 1905, tome 13, p. 139 (all papers cited to 1850).—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 173.
Rhegmatodes lacteus, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 147, plate 3, figs. 15, 16.
Polycanna purpurostoma, Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 169, plate 8, figs. 26–28; *Ibid*, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 147.

The bell-cavity is very shallow, so that the disk has almost the shape of a thick plano-convex lens, 50 to 100 mm. wide. There are 10 to 16 short, tapering, hollow tentacles, about one-fourth as long as the bell-radius. The basal bulbs of these tentacles have a wide lateral extension along the margin of the disk. There are no excretory papillæ, but only simple pores. Each tentacle is at the foot of a radial-canal and two rows of nematocysts extend down the sides of the tentacle. There are a very large number of permanently undeveloped, rudimentary tentacle-bulbs upon the margin, these being between 2 and 3 times as numerous as the radial-canals. The marginal lithocysts are 2 to 4 times as numerous as the tentacular rudiments. They are small and each one contains 2 spherical concretions. Velum is very narrow. 100 to 250 straight, narrow radial-canals and a slender, marginal ring-canal. The stomach is one-half to two-thirds as wide as diameter of disk. Its side walls are short and rudimentary and only about 2 to 4 mm. in length, so that the mouth can not be closed but is a wide circular opening, almost as wide as the stomach itself. The lips are as numerous as the radial-canals, elongate, pointed, and provided with an external, gelatinous, axial rib. Gonads linear and developed upon all of the radial-canals extending nearly from periphery of stomach to the circular vessel.

The entoderm of the stomach, tentacle-bulbs, and radial-canals is milky to slaty-blue in color; the stomach may be pink; all other parts colorless.

Widely distributed over the Red Sea, tropical Indian Ocean, and the Pacific, but not found in the Mediterranean.

The best descriptions have been given by Browne and Maas, and the following table, showing the range of variability, etc., is mainly derived from their works:

Table Showing Characters of Eight Specimens of Æquorea pensilis.

Diameter of disk.	Height of disk.	Diameter of stomach.	No. of well-developed tentacles.	No. of radial-canals.	No. of lips.	Remarks.
mm.	*mm.*	*mm.*				
45	20	26	10	120±	?	Described by Browne from Maldive Islands.
60	25	?	10+	100±	?	Indian Ocean.
60	30	?	15	150±	?	Indian Ocean.
60	20	43 diameter of mouth.	13	148	?	Indian Ocean.
100	?	50 to 60	16?	200±	200±	Maas, from Amboina.
90	?	50	10?	250±	250±	Maas, from Amboina.
30	12	12	16	100 to 120	100 to 120	Agassiz and Mayer, Fiji Islands.
50	20	19	10	105	105	Agassiz and Mayer, Tahiti.

Æquorea parva Browne.

Æquorea parva, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Supplementary Report No. 27, Roy. Soc. London, p. 146, plate 2, figs. 5–7.

Bell is 6 mm. wide, 4 mm. high. Plano-convex, lenticular, with very thick gelatinous substance. 4 to 8 tentacles, with large basal bulbs. 50 to 100 marginal bulbs and 50 to 100 lithocysts, each with 2 concretions. Velum quite wide. 13 to 16 simple radial-canals. Stomach flat, with circular periphery; about one-third as wide as the bell. 13 to 16 lips. Gonads sac-like upon the central thirds of the radial-canals. Galle Bay, Ceylon, June. Three specimens studied by Browne.

Æquorea conica Browne.

Æquorea conica, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 145, plate 1, fig. 2; plate 2, figs. 16–18.

Bell 7 mm. wide, 8 mm. high. Cone-shaped, with a bluntly-rounded apex and very thick walls. 26 to 30 small, slender tentacles, with conical basal bulbs which are said to lack excretory pores. These tentacles are about as long as the bell-diameter. 26 to 30 minute marginal bulbs alternate with the tentacles. 52 to 60 lithocysts, each with 2 concretions, between the marginal bulbs and tentacles. Velum narrow. About 16 radial-canals. Stomach

PLATE 44.

Fig. 1. *Zygodactyla grænlandica.* Pink-colored southern variety, natural size. Off Cape May, New Jersey, October 18, 1804. (See page 335.)

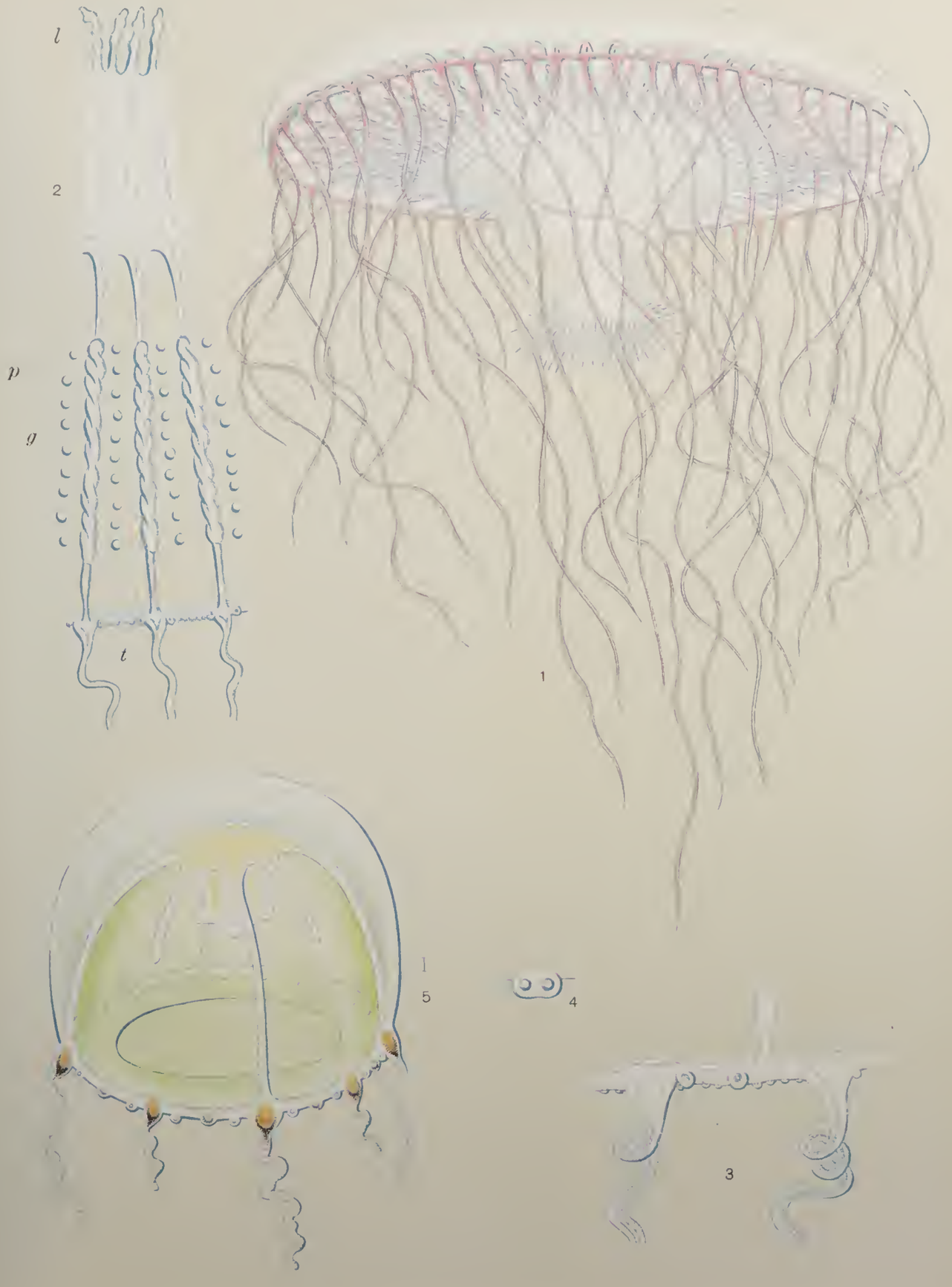
Fig. 2. *Zygodactyla grænlandica.* Oral view of a section of the subumbrella. *g*, gonads; *l*, lips; *p*, subumbrella papillæ; *t*, tentacles.

Fig. 3. *Zygodactyla grænlandica.* Part of the bell-margin showing tentacles, lithocysts, and excretion-papillæ.

Fig. 4. *Zygodactyla grænlandica.* One of the marginal lithocysts.

Fig. 5. *Æquorea albida*, young medusa. Agassiz Laboratory, Newport, Rhode Island, September 21, 1896.

Drawn from life, by the author.



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flat and about one-half as wide as the bell-diameter. Its margin is circular and there are about 16 long, slender lips. Gonads are on the proximal halves of the radial-canals, developed on the sides of the canals and laterally compressed. Found over the Pearl Banks, Gulf of Manaar, between Ceylon and India.

Genus ZYGODACTYLA Brandt, 1835, sensu Agassiz.

Zygodactyla, Brandt, 1835, Mém. Acad. Impériale des Sci. St. Pétersbourg, Sci. Nat., sér. 6, tome 2, p. 221.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 360.—Agassiz, A., 1865, North Amer. Acal., p. 103.—Fewkes, 1889, Report Commiss. Fish and Fisheries for 1886, p. 522.
Rhacostoma, Agassiz, L., 1850, Proc. Boston Soc. Nat. Hist., vol. 3, p. 342.
Polycanna, subgenus *Zygodactyla*, Haeckel, 1879, Syst. der Medusen, p. 231.

Brandt, 1835, established the genus *Zygodactyla* for a medusa found off the coast of Japan, called *Mesonema* (*Zygodactyla*) *cærulescens*. *Zygodactyla grœnlandica* L. Agassiz, will serve as the type of genus for Brandt's medusa proves to be an *Æquorea*.

GENERIC CHARACTERS.

Similar to *Æquorea*, but the subumbrella gives rise to rows of gelatinous, wart-like protuberances between the radial-canals. In *Æquorea*, on the other hand, the subumbrella is smooth.

In common with *Æquorea*, medusæ of *Zygodactyla* appear to be highly variable, both in color and in the relative number of the radial-canals, tentacles, lips, and lithocysts. The shape and size of the stomach change with age and with different states of contraction.

Were it not for the fact that the genus *Zygodactyla* is one of the old-established genera, I would prefer to consider it merely as a subgenus of *Æquorea*.

Zygodactyla grœnlandica L. Agassiz.

Plate 44, figs. 1 to 4.

Medusa æquorea, Fabricius, 1780, Fauna Grœnlandica, No. 357.
Medusa globularis, Mooeer, 1791, Nova Acta Phys. Med., Bd. 8, p. 33.
Æquorea grœnlandica, Péron et Lesueur, 1809, Ann. du Mus. Hist. Nat. Paris, tome 14, p. 339.—Lesson, 1843, Zooph. Acal., p. 313.
Æquorea globularis, Mörch, 1857, Beskriv af Grœnland, p. 96.
Rhacostoma atlanticum, Agassiz, L., 1850, Proc. Boston Soc. Nat. Hist., vol. 3, p. 342.
Zygodactyla grœnlandica, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 360.—Agassiz, A., 1865, North American Acalephæ, p. 103, figs. 153–155, *non* fig. 156.—Verrill, 1873, Report Com. Fish and Fisheries, 1871–72, p. 729, plate 37, fig. 275.—Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 156, plate 5, figs. 5, 6, 11, 12; 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 9, No. 3, plate 5, figs. 17, 19.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 25.
Polycanna grœnlandica, Haeckel, 1879, Syst. der Medusen, p. 232.

Southern variety (plate 44, figs. 1 to 4). The disk is about 115 mm. or more in diameter. The gelatinous substance is hyaline and rigid, being about 20 mm. thick in center and thinning quite abruptly to the edge. Aboral surface of disk flat or slightly concave in center. 84 to 97 straight, narrow radial-canals, the central portions of which contain the gonads. Velum rudimentary. Tentacles only slightly more numerous than radial-canals, long, with hollow tapering bulbs. The shafts of the tentacles are flattened radially and are very flexible. The excretion papillæ are situated near the bases of the tentacles and at intervals between them. 8 to 12 very minute lithocysts between each successive pair of tentacles; each lithocyst contains 2 spherical concretions. There is a single row of blunt, gelatinous, solid, rounded papillæ upon the subumbrella, between each successive pair of radial-canals (plate 44, fig. 2, *p*). Each row contains 6 to 13 papillæ. Stomach broad, flat, and sac-like, and terminates below in a long cylindrical throat-tube. The mouth is surrounded by long, tapering oral tentacles, which are equal in number to the radial-canals.

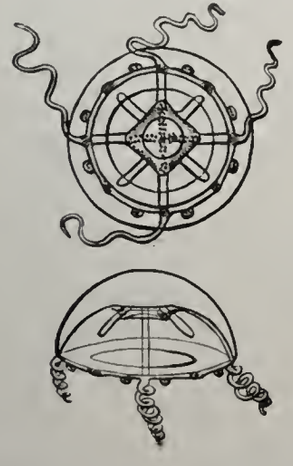

Fig. 192.—Young medusa of *Z. grœnlandica*, after Fewkes, in Bull. M. C. Z. at Harvard College.

The entoderm of the radial-canals, circular canal, gonads, and tentacles is of a delicate madder-pink to milky-white, the stomach and mouth parts being of a fainter hue of pink.

This medusa occurs in large swarms in pure ocean-water from the southern coast of Long Island to Beaufort, North Carolina, during summer and autumn. Mature individuals are abundant off the New Jersey coast in October. It is not found in bays or in brackish water, but is strictly a creature of the open sea. A large, relatively colorless variety of this medusa ranges from Cape Cod to Greenland. The southern variety is distinguished by its decided pink coloration, smaller size when mature, and in the fact that the tentacles are only slightly more numerous than the radial-canals, while the lithocysts are very small and 8 to 10 times as numerous as the tentacles. The excretion papillæ lack the green pigment observed in the northern variety of *Z. grænlandica*.

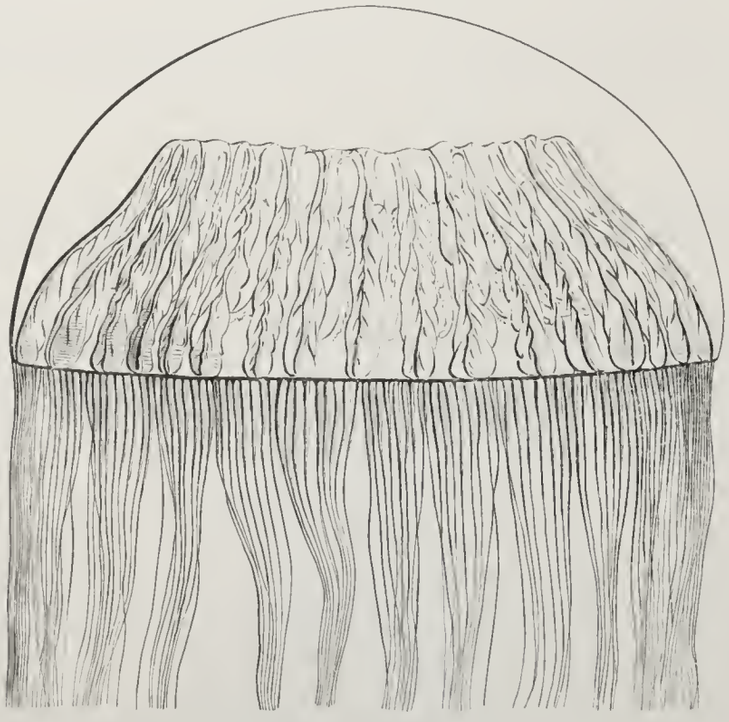

FIG. 193.—"*Zygodactyla crassa*," after A. Agassiz, in North American Acalephæ. Side view of medusa.

The southern variety of *Z. grænlandica* may bear the same relationship to the northern that the southern, pink-colored *Cyanea versicolor* bears to the brown-colored *Cyanea arctica* of northern waters.

Young medusa.—When about 3 mm. in diameter the bell is hemispherical in shape. There are 4 broad, straight radial tubes and 4 others that extend but a short distance from the periphery of the stomach towards the circular tube. There are 4 long tentacles at the bases of the 4 complete radial tubes and also 4 rudimentary tentacles in the radii of the 4 incomplete radial tubes. There are 8 lithocysts. Velum well developed, manubrium wide and shallow. The outer surface of the exumbrella is crossed by 4 radially situated rows of nematocyst-cells. These diminish in size with the growth of the medusa and are not seen in the adult. As development proceeds the tentacles increase more rapidly than the radial tubes. New radial tubes develop from the periphery of the stomach and extend towards the circular canal; at first they are very slender, but after reaching the circular tube they soon increase in caliber. The tubercles of the floor of the subumbrella begin to develop when the medusa has acquired 8 radial tubes; they first appear near the region of the periphery of the stomach.

Zygodactyla (?) crassa A. Agassiz.

Zygodactyla crassa, AGASSIZ, A., 1865, North Amer. Acal., p. 106, figs. 157, 159.
Polycanna crassa, HAECKEL, 1879, Syst. der Medusen, p. 232.

Adult medusa.—Bell hemispherical in form and about 300 mm. in diameter. About 350 long, marginal tentacles, more massive than in *Z. grænlandica*. Only about 32 radial tubes.

Velum well developed. Diameter of stomach about four-sevenths as great as that of bell. The stomach-walls are not capable of much extension and the mouth does not protrude beyond velar opening. Mouth surrounded by crenulated and folded lips, which are as numerous as the radial-canals. Gonads of very large size, occupying the whole lengths of the radial-canals from periphery of stomach to bell-margin. They are complexly folded and hang down into

FIG. 194.—Oral view of "*Zygodactyla crassa*," after A. Agassiz, North American Acalephæ.

the bell-cavity. Papillæ upon the subumbrella(?) Bases of tentacles colored with a faint greenish-blue tinge. Gonads slightly yellowish-green. Color of male gonads pinkish.

This medusa was found by A. Agassiz in Massachusetts Bay, at Nahant, but has not been observed since. Is it a variety of *Z. grænlandica?*

Genus ZYGOCANNA Haeckel, 1879, sens. ampl.

Zygocanna+Zygocannota, HAECKEI, 1879, Syst. der Medusen, pp. 214, 215.
Polyxenia (in part), ESCHSCHOLTZ, 1829, Syst. der Acalephen, p. 118.

The type species is *Zygocanna pleuronota*, described by Péron and Lesueur from the northern coast of Australia under the name *Æquorea pleuronota*.

GENERIC CHARACTERS.

Æquoridæ with forked or branching radial-canals, which arise at equal intervals from the periphery of the stomach. With 8 or more lips. Manubrium without a peduncle. Development unknown.

Haeckel distinguishes *Zygocanna* with 16 or more branched radial-canals and *Zygocannota* with 12 branched radial-canals. It seems best to unite these genera, adopting Haeckel's first name, *Zygocanna*. Haeckel's system makes no allowance for the possible discovery of medusæ with 8 to 11, or 13 to 15, branched radial-canals.

Very little is known of these medusæ. Their radial-canals arise at equal intervals from the periphery of the stomach and almost immediately bifurcate. The gonads are developed upon the peripheral branches.

Zygocanna is separated from *Zygocannula* by its lacking a gelatinous peduncle, which is found in *Zygocannula*, but I am inclined to believe that *Zygocannula* is the mature stage of *Zygocanna*.

Zygocanna pleuronota Haeckel.

Æquorea pleuronota, Péron et Lesueur, 1809, Annal. du. Mus. Hist. Nat. Paris, tome 14, p. 338.
Æquorea (Polyxenia) pleuronota, Eschscholtz, 1829, Syst. der Acalephen, p. 119.
Zygocanna pleuronota+Z. costata, Haeckel, 1879, Syst. der Medusen, pp. 214, 215, taf. 15, fign. 7, 8.
Zygocanna pleuronota, Bedot, 1901, Revue Suisse de Zool., tome 9, p. 488; *Ibid.*, 1905, tome 13, p. 153 (citation of all literature to 1850).

Our knowledge of this medusa is very imperfect. Péron and Lesueur's description is inadequate for modern requirements, and Haeckel states that the bell-margin of his *Z. costata*, which certainly seems to be identical with Péron and Lesueur's *pleuronota*, is "partially restored" in his figure. The only difference between Péron and Lesueur's *pleuronota* and Haeckel's *Z. costata* is that Haeckel's "species" has somewhat longer tentacles. The so-called disparity in numbers of radial-canals, lips, and tentacles is no greater than one would expect to find in different individual medusæ of the same species in any genus of the Æquoridæ.

Fig. 195.—*Zygocanna "costata,"* after Haeckel, in Syst. der Medusen=*Z. pleuronota.*

From Haeckel's *Z. "costata:"* Bell 40 mm. wide and 10 mm. high; shield-shaped and lenticular, with 32 well-developed, gelatinous, radial ribs on exumbrella. 16 spirally coiled tentacles, longer than bell-diameter. 80 to 100 small lithocysts each with 1 concretion. 16 canals arise from periphery of stomach and bifurcate, giving 32 terminal branches upon which the cylindrical, folded gonads are developed. Stomach cylindrical, with 16 lips. Coast of New Guinea. This may be only a stage of *Zygocannula diploconus.*

Péron and Lesueur's *pleuronota* appears to be 20 to 30 mm. wide; exumbrella with 40 to 50 radial ribs. Stomach cylindrical, with 16 to 20 lips. Tentacles shorter than the bell-diameter. North coast of Australia.

Zygocanna purpurea.

Æquorea purpurea, Péron et Lesueur, 1809, Annal. Mus. Hist. Nat. Paris, tome 14, p. 337.—Milne-Edwards, 1836-49, Cuvier's Règne animal, Zooph., planche 43, fig. 3.
Zygocannota purpurea, Haeckel, 1879, Syst. der Medusen, p. 215.—Bedot, 1901, Revue Suisse de Zool., tome 13, p. 153 (citation of literature to 1850).

Bell flat, shield-shaped, 80 to 100 mm. wide, 10 to 16 mm. high. Tentacles short and very numerous. 12 bifurcated radial-canals, with 24 gonads on their outer branches. Each gonad forms a cluster of 5 parallel lamellæ, with serrated, free, lower edges. All parts of the medusa are violet-purple. West coast of Australia. A modern description of this medusa is greatly to be desired.

Genus ZYGOCANNULA Haeckel.

Zygocannula, Haeckel, 1879, Syst. der Medusen, p. 216.—Bedot, 1901, Revue Suisse de Zool., tome 9, p. 488; *Ibid.*, 1905, tome 13, p. 153 (citation of literature to 1850).

The type species is *Zygocannula undulosa* from the north coast of Australia. This was described by Péron and Lesueur under the name *Æquorea undulosa. Z. diploconus* Haeckel from the Straits of Sunda appears to be identical with *Z. undulosa.*

GENERIC CHARACTERS.

Æquoridæ with forked or branched radial-canals, which arise at equal intervals from the periphery of stomach. Stomach mounted on a gelatinous peduncle. Development unknown.

Zygocannula is closely related to *Zygocanna*, but the stomach is mounted upon a peduncle, whereas this is lacking in *Zygocanna.* It is not improbable, however, that *Zygocannula* is only the mature condition of "*Zygocanna.*"

FIG. 196.—*Zygocannula diploconus*, after Haeckel, in Syst. der Medusen.

Zygocannula diploconus Haeckel.

Zygocannula diploconus + *Z. undulosa*, HAECKEL, 1879, Syst. der Medusen, pp. 216, 217, taf. 15, fig. 6.

Bell 60 to 100 mm. wide and higher than a hemisphere. Numerous well-developed radial ridges upon the exumbrella. 50 to 70 long tentacles at the ends of the branches of the radial-canals. These tentacles are longer than the bell-diameter. There are 200 to 300 small lithocysts, each with a single concretion. 25 to 35 radial-canals arise from the periphery of the stomach and bifurcate, so that 50 to 70 canals reach the circular vessel. The gonads are linear, folded, and developed upon the distal branches of the radial-canals, leaving both ends of each branch free. Medusa rose-red, gonads darker red. Straits of Sunda, Indian Ocean, Haeckel. Haeckel's description is derived from the study of a preserved specimen. It may be only an advanced stage of *Zygocanna pleuronota*.

Order TRACHYMEDUSÆ Haeckel, 1866.

Trachymedusæ, HAECKEL, 1866, Generelle Morphol. der Organismen, Bd. 2, p. LIX, Berlin.
Trachomedusæ, HAECKEL, 1879, Syst. der Medusen, p. 234.—MAAS, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 6; 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 21; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 488, Jena.—BIGELOW, 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 100.

CHARACTERS OF THE ORDER.

Veiled medusæ with free or inclosed lithocysts having concretions of *entodermal* origin. With simple, entire bell-margin, not cleft into lappets. The tentacles are usually solid, and the gonads are commonly developed upon the radial-canals. There may be 4, 6, or 8 radial-canals. The development is direct through a planula and an actinula stage, or by budding from a stolon-like larva.

The Trachymedusæ, I believe, may be regarded as medusiform actinulæ. In *Aglaura*, for example, the tentacles of the actinula larva become those of the medusa, and the bell grows out as an annulus from the sides of the actinula after some of the tentacles have become fully developed. The lithocyst clubs of Trachymedusæ contain entodermal concretions which are evidently not comparable with the vesicular, ectodermal, velar concretions of the Leptomedusæ. It is probable, therefore, that the Trachymedusæ and Narcomedusæ are to be regarded as actinulæ which are not homologous with the Anthomedusæ and Leptomedusæ, but have attained independently to a medusiform shape and appearance.

In this connection it is interesting to recall the recent discovery of Woltereck, 1905, that there is an apical sensory plate in the actinula larva of *Solmundella*, and also in the actinulæ of *Tubularia*, and Dawydoff has found a Solmundella-like medusa with a complexly developed, apical sense-organ above the stomach. In the Geryonidæ, some or all of the larval tentacles of the actinula degenerate before the medusa becomes mature, and other tentacles replace them. In *Craspedacusta* the medusæ are produced by budding from a stolon-like "hydroid."

The Trachymedusæ are distinguished from the Narcomedusæ by their uncleft bell-margin and simple annular velum. Frequently, but not invariably, the tentacles project from the sides of the exumbrella and their entodermal cores penetrate the gelatinous substance to the ring-canal.

Many of the Trachymedusæ, being independent of an attached hydroid stage, are widely distributed over the open oceans, being merely confined within more or less definitely defined ranges of latitude and extending within these limits around the world. The species are far more abundant in tropical or warm seas than in polar regions. Many of them are creatures of that which Bigelow (1909, Mem. Museum of Comparative Zool. at Harvard College, vol. 37, pp. 221–235) has aptly termed the "intermediate fauna"; that is to say they rarely or never approach the surface, being probably negatively phototoctic to light of any considerable intensity, and they live at depths ranging from several hundred fathoms to greater depths, or even to the bottom. Bigelow finds that great numbers of Trachymedusæ and other pelagic forms are found in the cold Humboldt, or Chili-Peruvian current, off the western coast of South America. These creatures are, moreover, confined quite strictly to the current, and on its western edge one suddenly enters upon a vast oceanic area nearly devoid of life. I have often observed this sudden transformation from a region rich in life to one barren of organisms on the edge of the Gulf Stream, off the Florida coast. Other factors beside those of light and temperature may also contribute to force these medusæ to remain at considerable depths beneath the sea, for I have frequently observed that they are more abundant near the surface when the ocean has been perfectly calm for a few days than under ordinary conditions; for if they are undisturbed by the movement of the waves some of these forms, in common with many of the rarely seen species of Ctenophoræ and Siphonophoræ, will gradually rise upward until they become visible in great numbers over the unrippled surface.

Owing probably to their great range in distribution we find many local races or closely related varieties of Trachymedusæ which it is exceedingly difficult to separate from their near relatives, and great confusion has been introduced into the synonymy of such forms. This is especially noteworthy in such genera as *Aglaura*, *Homœonema*, *Liriope*, and *Geryonia*.

We may define the families of the Trachymedusæ as follows:

Olindiadæ Haeckel, 1879. Some or all of the tentacles project from the sides of the exumbrella above the margin and have adhesive disks. Gonads linear, folded, or sac-like, and developed upon the 4 or 6 radial-canals. 4 lips.

Subfamily Petasidæ, Haeckel, 1879. Tentacles without adhesive disks. In other respects this family resembles the very closely allied Olindiadæ.

Limnocnididæ. Tentacles hollow, without adhesive disks, and projecting from the sides of the exumbrella above the bell-margin. Sexual products diffusely developed over the sides of the stomach. 4 to 6 radial-canals. Mouth a round opening. No centripetal canals.

Ptychogastridæ. Some filiform and some sucker-bearing tentacles, grouped in clusters. Gonads upon the sides of the 8 lobes of the stomach. 8 radial-canals. 4 quadratic lips. Centripetal canals present.

Trachynemidæ Gegenbaur, 1856. Tentacles solid, filiform and without adhesive disks. Linear or sac-like gonads on the 8 radial-canals. 4 lips. With or without a peduncle.

Geryonidæ Eschscholtz, 1829. Three sets of dissimilar tentacles. The gonads are flat, leaf-like expansions upon the 4 or 6 radial-canals. 4 or 6 lips. Stomach mounted upon a gelatinous peduncle.

Family OLINDIADÆ, sensu Goto.

Olindiadæ, Haeckel, 1879, Syst. der Medusen, p. 252.—Goto, 1903, Mark Anniversary Volume, pp. 15, 19.—Mayer, 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, pp. 18, 21.

Olindiadæ (in part), Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, part 3, p. 736; 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 150.

Perkins and Murbach conclude that the marginal concretions of *Gonionemus* are of entodermal origin and that this genus is one of the Trachymedusæ, while Goto, who is an exceedingly careful observer, concludes that the concretions of *Olindioides* are of ectodermal origin and that the medusa belongs to the Eucopidæ.

FAMILY CHARACTERS.

Veiled medusæ, in which some or all of the tentacles project from the sides of the exumbrella *above* the margin, while others may arise from the bell-margin. Some or all of the tentacles are provided with adhesive pads bearing a superficial resemblance to *suctorial* disks. 4 or 6 linear, sac-like, or papilliform gonads upon the 4 or 6 complete radial-canals. Blindly ending centripetal diverticula from the ring-canal may or may not be present. The lithocysts may project freely below the bell-margin or be inclosed within the gelatinous substance of the bell above the ring-canal.

The Olindiadæ form a well-defined group of shallow-water, bottom-living medusæ, the species of which have, apparently, quite similar habits each to each. The medusæ are as a whole widely distributed, but each species appears to be quite restricted and only locally abundant.

The exumbrella tentacles are connected with the ring-canal by entodermal roots and project more or less stiffly from the sides of the bell above the margin. These tentacles are always provided with aboral, disk-like, adhesive pads near their outer ends. Besides the exumbrella set, tentacles may arise from the velar margin. These are quite flexible, hollow, and may or may not be provided with adhesive pads. They are armed with rings or helices of ectodermal, nematocyst-bearing ridges.

The gonads are developed exclusively upon the walls of the radial-canals in the form of linear or sac-like folds. The gonad usually becomes longer than the portion of the canal upon which it is developed, and it is then reflected from side to side in a sinusoidal curve. Later hernia-like outgrowths may develop over the surface of the gonad and it thus acquires a papilliform aspect.

The development of *Gonionemus* has been studied by Perkins, 1903, but we know nothing of the manner in which the medusa arises from the hydroid. The growth of the medusa of *Olindias* was studied by Mayer, 1904, but its polyp-stage remains unknown.

The genus *Mæotias* Ostroumoff, 1896, appears to have marginal tentacles only, and apparently these lack adhesive disks, or at least such are not mentioned by Ostroumoff. I have, therefore, considered this genus to be one of the Petasidæ, not of the Olindiadæ.

The Olindiadæ are, however, very closely related to the Petasidæ, and I am much inclined to follow Bigelow, 1909, and unite the Olindiadæ and Petasidæ under one family, calling it Petasidæ. I am deterred from taking this step only because our knowledge of the Petasidæ is, with the exception of the genus *Gossea*, so apochryphal that I hesitate to classify these medusæ excepting in a group of their own from which they may be readily removed should future studies reveal them to science once again. As Bigelow shows there is no doubt of the close relationship between *Gonionemus* and *Gossea*.

A synopsis of the genera of the Olindiadæ follows:

Gonionemus A. Agassiz, 1862, 1865. The tentacles all project from the sides of the exumbrella above the margin and are all provided with adhesive disks. Lithocysts external. 4 radial-canals. No centripetal canals.

Cubaia Mayer, 1894. Similar to *Gonionemus*, but with two sorts of tentacles, one set arising from the bell-margin, the other set projecting from the sides of the exumbrella. Lithocysts external.

Vallentinia Browne, 1902. Similar to *Cubaia*, but with lithocysts adjacent to the ring-canal and inclosed on the inner side above the velum. (This is probably only a young *Olindias*).

Olindias F. Müller, 1861. Similar to *Vallentinia*, but with blindly-ending, centripetal diverticula from the ring-canal.

Olindioides Goto, 1903. Similar to *Olindias* but with 6 radial-canals (2 simple and 2 bifurcated). 6 gonads. Exumbrella tentacles projecting at various levels. 4 lips.

Genus GONIONEMUS A. Agassiz, 1862.

Gonionemus, A. Agassiz in L. Agassiz, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 530; 1865, North Amer. Acal., p. 128.—Murbach, 1895, Journal Morphol., vol. 11, p. 2.—Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 164.—Mayer, 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, p. 19.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 738; 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, p. 149.—Hargitt, 1904, Biol. Bulletin Woods Hole, vol. 6, p. 241.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 105.

Gonynema, Haeckel, 1879, Syst. der Medusen, p. 146.

Gonionema, Perkins, 1902, Johns Hopkins Univ. Circ., May, 1902; 1903, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, p. 750.—Goto, 1903, Mark Anniversary Volume, pp. 12, 19, 20.

The type species is *Gonionemus vertens* A. Agassiz, 1862, 1865; from Puget Sound, Pacific coast of North America.

Haeckel introduced the spelling "*Gonynema*," and Perkins proposed to change the name to "*Gonionema*," in an endeavor to correct, or improve upon, the original termination proposed by Agassiz. It appears to me that in the case of generic names we should retain the original spelling proposed by the author of the genus, regarding the name as a mere combination of letters which may or may not have significance or meaning. The strongest argument in favor of this view appears when we consider that if we are to correct the spelling of the generic names in zoology, a surprisingly large proportion of now familiar names must be considerably amended.

GENERIC CHARACTERS.

Olindiadæ with tentacles all similar each to each, and all projecting from the sides of the exumbrella above the margin, their entodermal cores traversing the gelatinous substance of the bell and being continuous with the entoderm of the circular vessel. All of the tentacles have pad-like, adhesive disks upon their aboral sides, near their outer ends. No tentacles arise from the bell-margin, but instead there are hollow basal bulbs below the insertions of the tentacles. No centripetal canals. 4 gonads on the 4 radial-canals. Gonads ribbon-like and deflected alternately to one side and the other of the radial-canals. Numerous external lithocysts upon the bell-margin between the tentacles, with entodermal concretions. Mouth with 4 lips.

Perkins, 1903, has made a partial study of the development, which is probably through a direct metamorphosis of the hydroid into the medusa. (See *Gonionemus murbachii*.)

Synopsis of the Described Forms of Gonionemus.

	G. vertens A. Agassiz.	G. murbachii Mayer.	G. agassizii Murbach and Shearer.	G. depressum Goto.	G. hornelli Browne = G. suvaensis.	G. pelagicus Bigelow = G. suvaensis.	G. suvaensis Agassiz and Mayer.
Shape and size of bell in mm.	Higher than a hemisphere. 17.5 high, 15 wide.	Slightly flatter than a hemisphere. 15 to 20 wide.	Hemispherical. 20 wide, 9 high.	20 wide, 8 high.	Hemispherical. 6 wide.	20 wide, 7 high, thin walls.	Flatter than a hemishere. 8 wide.
Number of tentacles.	60 to 70	60 to 80	52 to 80 short.	59 to 64	70± of various lengths.	50	70
Number of lithocysts.	60 to 70. Alternating with tentacles.	At least half as many as tentacles.	1.5 times as many as tentacles.	Twice as many as tentacles.	16	16	16
Shape and size of manubrium.	Large, with mouth at level of velar opening.	Smaller than in G. vertens.	As in G. murbachii.	As in G. murbachii, but with simple unfringed lips.	Broad, cruciform, with a short peduncle.	Flask-shaped, with 4 fringed lips.	As in G. vertens.
Form and position of gonads.	Sinuously reflected, on greater part of radial-canals.	As in G. vertens.	As in G. vertens.	As in G. vertens.	Only on outer ends of radial-canals. Folded and lobed.	On outer thirds of the 4 radial-canals. Sinusoidal.	Sinusoidal. On outer halves of the radial-canals. Immature.
Color.	Gonads deep-red, radial-canals deep-brown, bell yellowish-green.	Gonads, radial-canals and margin rich-brown. Lips white. Brilliant emerald spot at root of each tentacle.	Brown.	As in G. murbachii, but mouth is green.	?	Manubrium and tentacles yellowish-green. Brown pigment-spots at bases of tentacles.	A green pigment-spot at each per-radial angle of stomach. Colors very much as in G. murbachii.
Where found.	Puget Sound, Gulf of Georgia, Pacific coast of North America.	In Eel Pond at Woods Hole, Massachusetts.	Aleutian Islands and at Naba Bay, Japan.	Yokohama, Japan.	Gulf of Manaar, near Ceylon.	Suvadiva Atoll, Maldive Islands, Indian Ocean.	Suva Harbor, Fiji Islands, south Pacific.
Remarks.	Distinguished by very high bell and deep red-brown color.		Closely allied to G. depressum.	Distinguished by numerous lithocysts.		Color peculiar.	

PLATE 45.

Fig. 1. *Gonionemus murbachii*. Side view of mature medusa. Eel Pond, Woods Hole, Massachusetts, July 22, 1897.

Fig. 2. *Gonionemus murbachii*. Oral view of a part of the bell-margin, showing the insertion of a tentacle, its bulbous base, and two lithocysts.

Fig. 3. *Gonionemus murbachii*. Showing the outer end of a tentacle with its adhesive "sucker" and sharply bent extremity.

Fig. 4. *Gonionemus murbachii*. Aboral view of the mature medusa, showing the confluence of the 4 radial-canals through an intermediate vessel.

Fig. 4. Drawn from life by Dr. Arnold Graff and presented for reproduction by Dr. Louis Murbach. Other figures are from life, by the author.

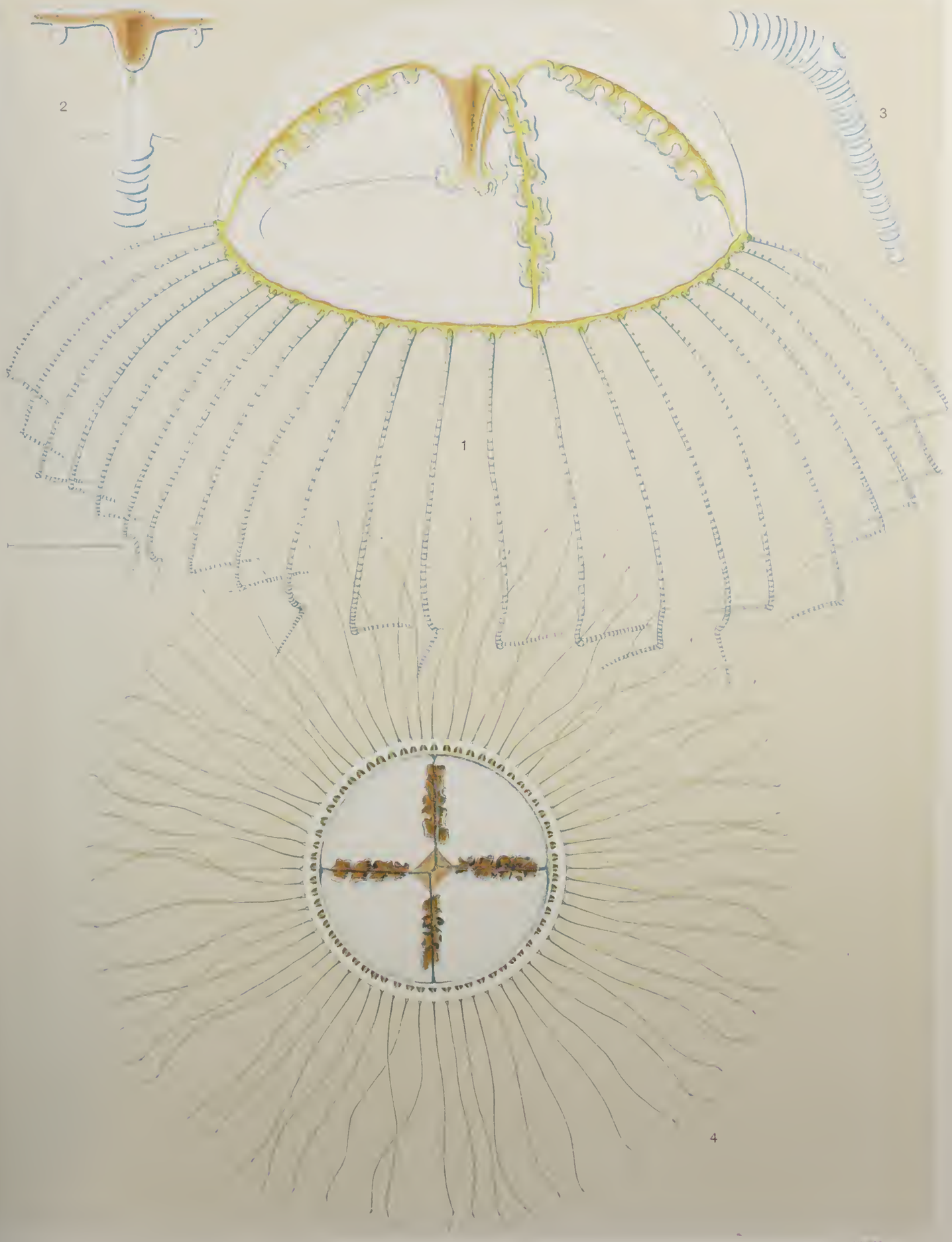
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Plate 46.

Fig. 1. *Gonionemus murbachii*, from Woods Hole, Massachusetts. Profile view of mature medusa, 1.25 times natural size.

Fig. 2. *Gonionemus murbachii*. Oral view of the mature medusa.

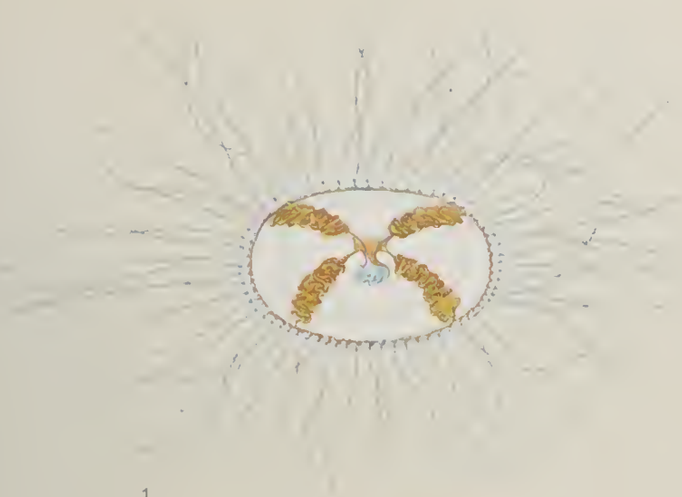
Fig. 3. *Gonionemus murbachii*. Oral view of a sector of the bell showing form of gonads, tentacles, lithocysts, and tentacle-bulbs.

Fig. 4. *Aglaura hemistoma*. Meridional section showing exumbrella (*ex*), male gonad (*g*), circular muscles of the subumbrella (*m*), subumbrella ectoderm (*s*), and stomach-cavity (*st*). (See page 398.)

Fig. 5. *Aglaura hemistoma*. Meridional section of the bell showing exumbrella (*ex*), circular muscles of the bell cut across (*m*), ring-canal (*rc*), subumbrella ectoderm (*s*), tentacle (*t*), and velum (*v*).

Fig. 6. *Cubaia aphrodite*, green variety. Key West, Florida, May 27, 1897. (See page 351.)

Fig. 1 drawn from life by Mr. Hyashi. Figure 2, from life by Dr. Arnold Graff. These drawings were kindly lent for reproduction by Dr. Louis Murbach. Other drawings are from life, by the author.



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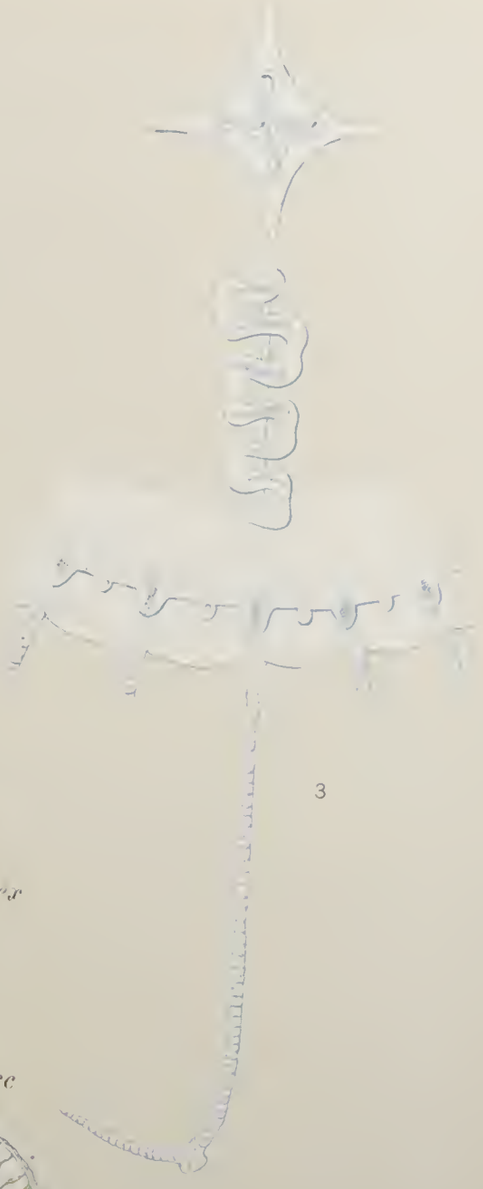

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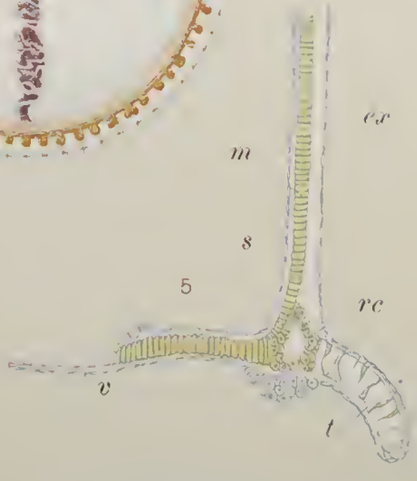

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6

Bigelow, 1909, has examined more of the so-called "species" of *Gonionemus* than has any other student of the medusæ. He concludes that the species fall under two groups:

(1) The *suvaensis*, *pelagicus*, and *hornelli* group with gonads restricted to only a fraction of the lengths of the radial-canals and with 16 lithocysts; and (2) the *vertens*, *agassizii*, *depressum*, and *murbachii* group with gonads upon nearly the entire lengths of the radial-canals, and with numerous lithocysts.

Bigelow concludes that there is but one species in group 1 and this should be called *G. suvaensis*. He also finds that the differences between *G. vertens* and *G. murbachii*, although slight, are apparently constant, consisting in the higher bell and more slender tentacles of *G. vertens*.

Gonionemus vertens A. Agassiz.

Gonionemus vertens, Agassiz, A., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 350; 1865, North Amer. Acal., p. 128, figs. 197-201.—Murbach and Shearer, 1903, Proc. Zool. Soc. London, vol. 2, p. 183.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 106.

Gonynema vertens, Haeckel, 1879, Syst. der Medusen, p. 147.

Bell 17.5 mm. high, 15 mm. wide, with thin walls. About 60 to 70 tentacles, twice as long as bell-diameter. A large oval, bulb-like swelling upon bell-margin below the insertions of each of the tentacles. The tentacles are ringed with helical ridges of nematocysts and are thick and heavy in appearance. Each tentacle has a well-developed, aboral, adhesive pad near its outer end, beyond which the tentacle suddenly bends at a right angle with its main shaft. The lithocysts are external and alternate with the tentacles in position. The manubrium is well developed, so that the mouth is at the level of the velar opening. The lips are fringed. There are 4 sinuously reflected gonads on the 4 radial-canals. Gonads deep red, radial-canals deep brown, bell yellowish-green.

Puget Sound, Gulf of Georgia, British Columbia, and Washington, Pacific coast of North America.

The habits of this medusa appear to be similar to those of *G. murbachii*. It is found among the kelp near the shores in July.

This species is distinguished by its high bell, long slender tentacles, and deep-red gonads. It appears to be locally abundant.

Gonionemus murbachii Mayer.

Plate 45, figs. 1 to 4; plate 46, figs. 1 to 3.

Gonionemus, *sp.*, Murbach, 1895, Journal Morphol., Boston, vol. 11, p. 493.

Gonionemus vertens, Hargitt, 1897, Zool. Bulletin, Boston, vol. 1, p. 27, 5 figs. (regeneration); 1899, Biol. Bulletin Woods Hole, vol. 1, p. 41, figs. 7-20 (grafting and regeneration); *Gonionemus*, *sp.*, 1900, Science, N. S., vol. 12, p. 341 (variations); 1901, Biol. Bulletin Woods Hole, vol. 2, p. 233, figs. 8-14, plates 1-4, 46 figs. (variations of the medusa); *Gonionemus murbachii*, 1901, American Naturalist, vol. 35, p. 593, fig. 60; *Gonionema*, 1902, Biol. Bulletin Woods Hole, vol. 4, p. 1, 11 figs. (regeneration); *Gonionemus murbachii*, 1904, Bull. U. S. Bureau of Fisheries for 1904, vol. 24, p. 53, plate 6, fig. 1*a*.—Morgan, 1899, American Nat., vol. 33, p. 939, 12 figs. (regeneration); 1907, Regeneration by Morgan, translated into German by M. Moszkowski, Leipzig, p. 195, fig. 55 A-D.

Gonionemus, Loeb, 1900, American Journ. Physiol., vol. 3, pp. 383-396; 1905, Studies in General Physiology, Chicago, pp. 553, 559, 754 (effects of ions); 1906, Journal Biol. Chemistry, New York, vol. 1, p. 431 (effects of magnesium); 1906, Dynamics of Living Matter, Columbia Univ. Biol. Series, No. 8, p. 81.—Perkins, 1901, Biol. Bulletin Woods Hole, vol. 2, p. 363, 2 figs. (order of growth of tentacles).

Gonionema murbachii, 1902, Johns Hopkins University Circ., vol. 21, p. 87, 11 figs. (development); 1902, Biol. Bulletin Woods Hole, vol. 3, p. 172, 7 figs. (degeneration phenomena in the larvæ); 1903 Proc. Acad. Nat. Sci. Philadelphia, vol. 54, p. 750, 21 figs., plates 31-34 (development).

Gonionema vertens, Nutting, 1901, Bull. U. S. Fish Commission, p. 382, fig. 103.

Gonionemus murbachii, Mayer, 1901, Sci. Bulletin Brooklyn Inst. Museum, vol. 1, No. 1, p. 5; 1906, Carnegie Institution of Washington Publication No. 47, p. 43.—Yerkes, 1902, American Journal Physiology, vol. 6, p. 434; *Ibid.*, vol. 7, p. 181; 1904, Biol. Bulletin Woods Hole, vol. 6, pp. 84, 324 (reactions to stimuli); 1906, Journal Comp. Neurology and Physiol., vol. 16, No. 6, p. 457 (reactions and behavior).—Murbach, 1903, Amer. Journal Physiol., vol. 10, p. 201 (static function); 1903, Science, ser. 2, vol. 17, p. 192; 1907, Biol. Bulletin, vol. 14, p. 11 (concretions entodermal, reactions to light).—Bigelow, H. B., 1907, Bulletin Museum Comp. Zool. at Harvard College, vol. 48, p. 287, plates 1-8 (nuclear cycle, early development).—Jennings, 1906, Behavior of the Lower Organisms, Columbia University Biol. series, vol. 10, pp. 192, 211, 214, 219, 221, 227, 230, figs. 118-120 (behavior and reactions to stimuli).—Morse, 1906, Journal Comp. Neurol. and Physiol., vol. 16, No. 6, p. 450 (behavior and reactions to stimuli); 1907, American Naturalist, vol. 41, p. 683.

Gonionema murbachii, Yerkes and Ayers, 1903, American Journal Physiol., vol. 9, p. 279, 2 figs. (reactions to stimuli).—Hyde, 1902, Biol. Bulletin Woods Hole, vol. 4, p. 40, 3 figs. (histology and anatomy of nervous systems).

Gonionemus, Maccallum, 1907, Journ. Biol. Chemistry, New York, vol. 2, No. 4, p. 385 (citation of Loeb's researches).

The following are the dimensions of a mature medusa which had 71 tentacles:

Diameter of bell, 19.5; height of bell, 9; length of tentacles, 15; width of velum, 3.5; width of stomach at base, 4.5; length of stomach, 5; length of each radial-canal, 10; length occupied by gonad upon each radial-canal, 8.

Adult medusa (plate 45, figs. 1 and 4; plate 46, figs. 1 and 2).—The bell is slightly flatter than a hemisphere and is about 15 to 20 mm. in diameter. The gelatinous substance is quite rigid. It is thin at the aboral pole of the bell and decreases regularly in thickness toward the margin. At the base of each tentacle, on the velar side of the margin, there is a well-developed oval bulb which is hollow, its lumen being connected with that of the ring-canal. There are 60 to 80 stiff, slender tentacles which are about three-quarters as long as the bell-diameter. The shafts of these tentacles are covered with numerous helically wound rings of nematocyst-cells. For the greater part of their length the tentacles are quite straight and stiff. Near the outer end, however, there is a small, pad-like, nematocyst-bearing, adhesive organ upon the aboral surface of the tentacle (plate 45, fig. 3) and at this point there is a sharp bend at right angles to the direction of the main shaft of the tentacle. These adhesive pads serve to anchor the medusa to seaweed, etc. The tentacles all project from the sides of the exumbrella at a short distance above the bell-margin. The entodermal roots of the tentacles project inward into the gelatinous substance of the bell to the ring-canal (plate 45, fig. 2). There are typically half as many lithocysts as there are tentacles. The lithocysts are situated on the bell-margin between the tentacles. According to Perkins, the lithocysts bear a very definite relation, both in place and time of development, to the tentacles. This will be discussed in the account of the growth of the medusa.

Each vesicular lithocyst contains a single, small club which bears a spherical concretion. The velum is well developed. There are 4 straight, narrow radial-canals. The manubrium is spindle-shaped and cruciform in cross-section. It does not extend quite to the velar opening. There are 4 recurved, crenated lips. There is a small peduncle, down which the radial-canals extend into the stomach. The 4 gonads are developed upon the greater part of the 4 radial-canals. They are ribbon-like and extend from the base of the peduncle to a point near the circular canal, but they never touch the circular canal. Each gonad is longer than the portion of the canal upon which it lies and is therefore thrown or reflected into a series of sinusoidal folds to one side and the other of the radial-canal (plate 46, fig. 3). The entoderm of the gonads, radial tubes, and circular canal is rich brown. The entoderm of the manubrium is of a darker brown, marked near the 4 angular perradial edges with pink. The lips are white. There is a brilliant emerald or grass-green pigment-spot in the entoderm at the root of each tentacle near the circular canal.

This medusa was first described by Murbach from the "Eel Pond," a small body of salt water, of about 5 acres in area, at Woods Hole, Massachusetts. It has continued to reappear each summer in large numbers in this small pond since its discovery in 1894. The medusa has been found occasionally in Woods Hole Harbor outside of the Eel Pond, and it is reported also from Noank, Connecticut, and from Hadley Harbor, Muskegat Island (Murbach).

Professor Perkins has given a graphic account of the normal habits of *Gonionemus*, which is so attractive that I can not refrain from quoting it.

> "*Gonionema* is a very attractive feature of the Woods Hole fauna. Its exquisite glassy umbrella, marked with a cross of yellow or brown by the four radial-canals and the gonads, a brilliant row of closely-set spots of gleaming phosphorescent green outlining its edge, a fringe of delicate streaming tentacles strung with beadlike clusters of thread-cells, are all more or less familiar to many American biologists.
>
> "On cloudy days or toward nightfall the medusa is very active, swimming upward to the top of the water, and then floating back to the bottom. In swimming it propels itself upward with rhythmic pulsations of the bell-margin, the tentacles shortened and the bell very convex. Upon reaching the surface the creature keels over almost instantly, and floats downward with bell relaxed and inverted and the tentacles extended far out horizontally in a wide snare of stinging threads which carries certain destruction to creatures even larger than the jelly-fish itself.
>
> "*Gonionema* continues this fishing, with little respite, all day long in cloudy weather. Occasionally it fastens itself to a blade of eelgrass or some other object near the bottom, or stops midway in its course with tentacles extended. In this position it is well-nigh invisible, but a deadly foe to small fish or crustaceans which cross in its path."

The development has been studied by Murbach, 1895, and more thoroughly by Perkins, 1903. The eggs are normally laid at about one hour after sunset from about July 1 until the last of September. They are cast out into the water through dehiscence and each female may lay eggs every night for a week. The dehiscence of the eggs on any single night is accomplished, however, in a few minutes. The eggs are brown in color and 0.7 mm. in diameter. Segmentation is total and equal; a hollow 1-layered blastula results, and then the entoderm is formed by delamination, the cells of the blastula wall dividing at their inner ends and the inner daughter cells forming the entoderm. These entodermal cells soon increase in size and obliterate the blastula cavity and a solid, spindle-shaped, ciliated planula develops. This planula is about 1 to 1.5 mm. long, 12 hours after the egg was fertilized. Then the cœlenteric cavity appears in the internal entodermal cells near the posterior end of the planula. After swimming through the water, or gliding over the bottom with a wave-like movement, the planula fixes itself to the bottom by its forward end. The mouth breaks through at the upper end of the fixed planula, or hydra as it has now become. Thus the mouth appears at that which was the posterior end in the free-swimming planula. 2 tentacles develop 180° apart, then 2 others in the diameter 90° away from the first pair, thus forming an oral zone of 4 tentacles. The first tentacles usually appear about one week after the larva has become attached, or three weeks after the fertilization of the egg. The mouth becomes cruciform, the arms of the cross being in the radii of the 4 tentacles; and the cœlenteron is also cruciform in cross-section and extended in the planes of the tentacles and mouth-slits. The 4 tentacles become 3 to 4 times as long as the body of the polyp. They often stretch out, touching the bottom, and when the tips of the tentacles touch the bottom they spread out, "forming a sole-like surface which is closely applied to whatever object the polyp is settled upon." Buds develop from the sides of the polyps below the zone of tentacles. These buds are formed from the ectoderm, mesoglœa, and entoderm of the parent polyp. They are at first hernia-like projections from the side of the polyp, but after about 5 days they become elongated, spindle-shaped, and finally they become detached. They occasionally settle down at once upon the bottom, but usually move through the water for 2 to 4 days before this is accomplished. The bud attaches itself by the end which was outermost (*i. e.*, away from the parent), while its mouth develops upon the end which was nearest the parent. The budded larva then acquires 2 and finally 4 tentacles, these developing 3 to 5 days after the larva has become attached.

The development of the medusa from the polyp has not been observed. Perkins surmises that it is probably through direct metamorphosis, as in *Liriope*, but of this we have no actual proof.

Perkins observed some interesting degeneration phenomena in his reared larvæ, the account of which we present in his own words.

> "For some reason or other, not understood at present, the larva in one of my aquarium jars began when three months old to exhibit most singular forms and activities. All appearance of the hydra form was lost, ectoderm and entoderm becoming indistinguishable and cell outlines dissolved. The larva in this condition had very much the appearance of an amœba. The specimens slumped down on the bottom of the aquarium in a shapeless mass, and by protoplasmic flowing changed their shape through an endless variety of forms, moving slowly from point to point. Thin pseudopodia were sent out, along which the substance of the organism flowed, and by the breaking of the connecting isthmus divided into two. The fragments became smaller and smaller until no longer recognizable. These abnormal larvæ remained alive for six weeks, after which no trace of them was to be seen."

The youngest medusa found by Perkins had 8 tentacles, the 4 radial being larger than the 4 interradial. Perkins believes that the 4 radially placed tentacles are the 4 tentacles of the hydra-stage. There are 4 lithocysts which are placed in definite positions relative to the 8 tentacles.

Thus, to quote from Perkins, if—

> "We look at the bell-margin from the oral side, the newly arisen tentacles in the four quadrants have apparently crowded in between the sense-organ and the perradial tentacle, which comes before it as the hands of a watch go. The relation which is here exhibited in the youngest stage of the free-swimming gonosome is the same throughout the growth of the medusa:

Wherever a rudimentary or newly arisen tentacle lies on the bell-margin, it will always, normally, be found to lie just in front of a newly arisen sense-organ, and just after a larger tentacle, i. e., one of an earlier cycle."

There is thus a cyclic symmetry in the order of appearance of the marginal sense-organs with reference to the tentacles.

New tentacles develop 4 at a time 90° apart so that they occupy identical positions in the four quadrants. Very often, however, the 4 new tentacles do not appear simultaneously; but first 2 appear 180° apart and then 2 more 90° from the first pair.

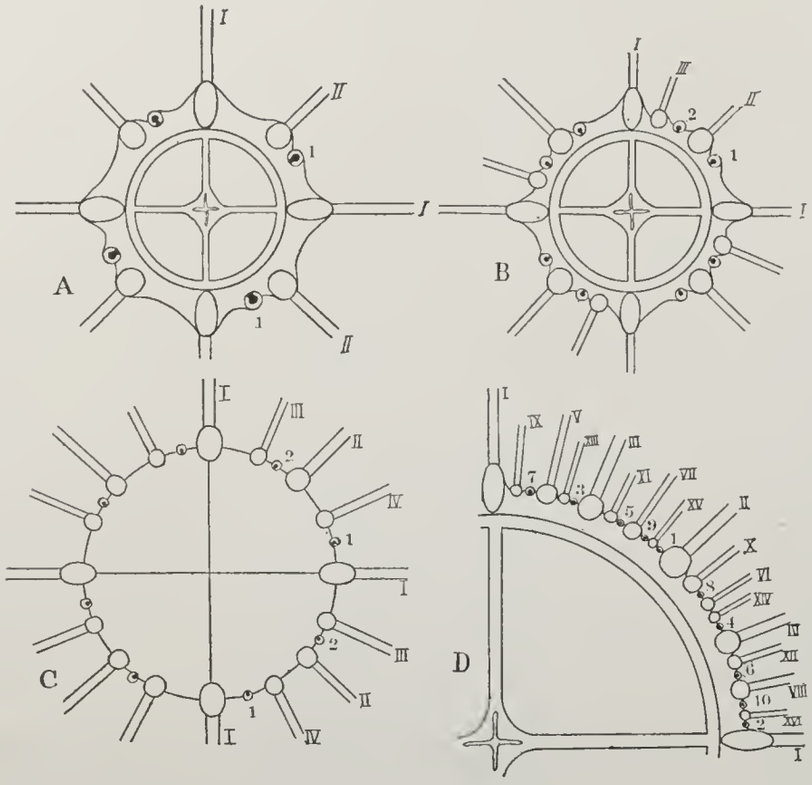


FIG. 197.—Sequence of the development of the lithocysts and tentacles in *Gonionemus murbachii*. *A*, youngest stage; *D*, mature state. After Perkins, in Proc. Acad. Nat. Sci., Philadelphia. The sequence of the lithocysts is shown in Arabic numerals, 1 being the oldest (first formed) and 10 the youngest (last formed).

The order of appearance of the tentacles and the lithocysts will be made clear through an inspection of the text-figure 197 reproduced from Perkins, 1903, Proc. Acad. Nat. Sci. Philadelphia, for 1902. The lithocysts finally become nearly as numerous as the tentacles.

Miss Ida Hyde, 1902, has made an interesting study of the nervous system of *G. murbachii*. She finds that there are three marginal nerve-rings, one below and two above the attachment of the velum; and there are also nerve chains along the radial-canals and a nervous network over the subumbrella. The ganglion-cells are bipolar and multipolar.

The variations of the medusa have been studied by Hargitt, 1901. Among about 2,000 specimens he found a range of from 2 to 6 radial-canals and cases of forked and trifid tentacles were observed. The forking may arise at the base or from the shaft of the tentacles. Hargitt's smallest medusa was 2 mm. wide and had 29 tentacles, while his largest was 19 mm. wide and had 68 tentacles. One 15 to 16 mm. wide had 72 tentacles. About 5 per cent of the medusæ have other than 4 radial-canals.

The regeneration of *Gonionemus* has been studied by Hargitt and also by Morgan. Hargitt carried out an interesting series of experiments in grafting in the medusa and he finds that they show a well-marked polar orientation. No successful aboral grafting of medusæ could be made, but the bell-margins of different individuals would readily unite.

When the bell-margins of two individuals were united by their bell-edges, the margins of each having been cut away, they soon coalesced everywhere around the rim of each, excepting

at one small opening; and under these conditions coördinated movements were made when the animals were stimulated. Apparently also some spontaneous movements were executed, but this is uncertain.

It appears from the works of Hargitt and of Morgan that the power of regeneration is slight in *Gonionemus*, but the bell heals over by bending in and the cut edges fuse, thus reforming the medusa shape. In some instances after the bell-margin has been removed, the tentacles, lithocysts, and velum do not regenerate, but the bell-margin bends upward and inward, and the bell-opening becomes smaller and smaller, so that finally the bell assumes a balloon shape, the outer surface of the balloon being the subumbrella (see Hargitt, 1899, p. 43, figs. 13 to 16). I have observed a similar phenomenon in *Cassiopea* under similar conditions. The regenerative activity in *Gonionemus* is mainly effected at the expense of the intact portions of the body proper, and although new manubria, tentacles, velum, lithocysts, or radial-canals may regenerate, this power is not possessed to any marked degree in comparison with the somewhat remarkable ability in the medusa to reform the shape of the medusa body through mere coalescence and healing of cut edges (see Morgan, 1899).

Yerkes, Yerkes and Ayers, and Morse have studied the reactions of *Gonionemus* to external stimuli, with a view to discover the effects these reactions may have upon the normal habits of the medusa. The peculiar "turning-over reaction" which ensues when the medusa reaches the surface has been well described by Perkins. Yerkes believes that this turning reaction is due, in part at least, to the effect of the strong light at the surface of the water. Yerkes states, however, that this reaction may take place in the dark, and that therefore, while light is a contributary cause to the turning reaction, it is not a necessary or a sole cause. Morse, 1906, denies that light is an important factor in causing the turning reaction; neither is this turning due to the effect of the oxygen of the air, or of lack of oxygen, for the reaction takes place when the medusa swims upward and reaches the surface, even when the surface of the water is covered by vapor of NH_4Cl, held in suspension in water vapor. On the other hand no reversal takes place if the medusæ swim upward against a film of olive oil, or against a horizontal glass plate. The reversal takes place even if half of the velum be removed. Morse does not attempt to define the cause for the reaction, but merely states that it is a "normal reaction."

Light may or may not exert a directive influence upon the medusa, but this question is still in dispute; Morse claims that there is no directive influence in light, but Yerkes states that if the medusa has been in weak light then brilliant illumination of one side of the bell brings about movement toward the region of lower illumination. Both observers agree that if the medusæ be placed in an aquarium one portion of which is brilliantly lighted and another dark or shaded, that the greater number of the medusæ will soon be found in a relatively quiescent state in the shaded portion of the aquarium. Morse claims that this is due simply to the fact that the medusæ swim in all directions through the lighted region, and if by accident they enter the shadow they cease swimming and sink passively to the bottom, thus being "trapped" in the shaded area. Yerkes on the other hand claims that *Gonionemus* definitely turns from the region of strong stimulation toward the shaded portion of the aquarium. There are other important matters in dispute between these observers, for the study of which the reader is referred to their papers cited above.

Yerkes and Ayers found that the reaction time to ordinary daylight is 7 seconds, to sunlight only 5.5, and for weak daylight 9.4 seconds. The reaction time to electrical stimuli ranges from 6 to 20 seconds, according to the intensity of the stimulus and the place stimulated. The reaction time is shorter when the radial-canals are stimulated than it is when the interradial regions are stimulated. The reaction time to photic stimuli ranges from 1 to 10 seconds, the subumbrella being more sensitive to effects of light than the exumbrella. Medusæ at rest react to light as do those already in movement (Morse, 1907).

The tentacles in the radii of the radial-canals are apparently more sensitive than are the other tentacles. When cut away from the bell the tentacles soon tire and their reactions become weak. Murbach, 1907, finds that the general subumbrella epithelial tissue, not exclusively the marginal papillæ, is responsive to light-stimulation.

Loeb, 1900, 1905, 1906, has carried out studies upon the influence of the various salts of sea-water in maintaining or inhibiting pulsation in *Gonionemus murbachii*. He finds that if we cut away the margin of the bell the center does not pulsate spontaneously in sea-water.

This observation is, however, contrary to those of Yerkes and of Mayer, who noted irregular, but spontaneous, pulsations of the center when in sea-water. *Gonionemus*, therefore, belongs among those medusæ (such as *Aurelia* and *Dactylometra*) which are not completely paralyzed in sea-water by the removal of their central (marginal) nervous system.

Loeb finds, however, that the center of the bell of *Gonionemus* beats *very rapidly* and *rhythmically* in a solution of pure NaCl, and the more rapidly the higher, within certain limits, the concentration of the NaCl solution. He also finds that the addition of small amounts of $CaCl_2$ or $MgCl_2$ to the NaCl solution retards or inhibits the pulsations. Also any salt which precipitates Ca or Mg, if added to sea-water, will cause pulsation in the center of *Gonionemus*. Loeb therefore concludes that the center of *Gonionemus* is prevented from pulsating in sea-water by the presence of Ca and Mg ions.

Mayer, 1906, finds that the center of *Gonionemus murbachii* pulsates *slowly*, but constantly and without pauses in a solution containing the amounts and proportions of $NaCl + KCl + CaCl_2$ found in sea-water, but without magnesium. The pauses so characteristic of the normal pulsation of *Gonionemus* are therefore due to the presence of magnesium in the sea-water. It would seem, indeed, that pulsation is more powerfully inhibited by magnesium than by calcium.

In the case of *Cassiopea*, Mayer, 1908, finds that pulsation is so strongly stimulated in a solution containing only the $NaCl + KCl + CaCl_2$ of sea-water that after many hours of violent contractions sustained tetanus, accompanied by a rupture of the muscles, is produced. This tetanus may, however, be overcome and normal pulsation restored by adding to the solution of $NaCl + KCl + CaCl_2$ the amount of magnesium found in sea-water.

Magnesium, calcium, and potassium, through their inhibitory, or anesthetic, influence overcome the too powerful stimulus due to Na upon *Cassiopea*.

H. B. Bigelow, 1907, has carried out an elaborate study of the nuclear cycle in *Gonionemus murbachii*. The somatic number of chromosomes is probably 24. No centrosome is visible until the metaphase, and it is a minute granule at the focus of the spindle fibers, which disappear after the anaphase. In the reconstruction of the nucleus the nucleolus is formed by a condensation of chromatin granules. The egg aster disappears at the close of the second maturation division. The spermatozoan enters the egg with its head and middle piece, but the middle piece soon disappears. The sperm introduces the new aster, which centers at some little distance from the sperm nucleus. This sperm aster then divides and forms two asters which accompany the sperm nucleus in its migration through the egg. No sperm centrosome was seen. Bigelow's paper abounds in important details and should be consulted by those interested in the early developmental phases of the sperm or ova.

Gonionemus agassizii Murbach and Shearer.

Gonionemus agassizii, Murbach and Shearer, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 73; Proc. Zool. Soc. London. vol. 2, p. 185, plate 21, figs. 1–3; plate 22, fig. 3.—Kirkpatrick, 1903, Annals and Mag. Nat. Hist., ser. 7, vol. 12, p. 618,

Bell about 20 mm. wide, 9 mm. high, hemispherical. 52 to 80 tentacles with thick bases and well-marked peronial grooves. Tentacles about two-thirds as long as bell-diameter. The lithocysts outnumber the tentacles in the ratio of about 3 to 2. Usually there are 2 lithocysts between each successive pair of tentacles, but they are quite irregular in arrangement. Gonad much folded, color brown. Found in a small salt lake at Unalaska, Aleutian Islands. Kirkpatrick's medusa from Japan is certainly *G. depressus*.

Gonionemus depressus Goto.

Gonionema depressum, Goto, 1903, Mark Anniversary Volume, article 1, p. 12, plate 2, figs. 10–13; plate 3, figs. 21, 22.

When mature the bell is somewhat flatter than a hemisphere, and is about 20 mm. wide and 8 mm. high; but when small it is relatively higher, for in a specimen 4 mm. wide it is also 4 mm. high. Bell evenly rounded, its walls of only moderate thickness. When mature there are about 59 to 64 tentacles, which arise from the sides of the bell at a zone slightly above the bell-margin. The entodermal cores of these tentacles traverse the gelatinous wall of the bell, and are continuous with the entoderm of the ring-canal. All of these tentacles arise at one and the same level. They are about as long as the bell-radius, are highly flexible, but not

very contractile, and are armed with many incomplete, ring-like nematocyst-warts. Near the outer end on the inner side of each tentacle is a prominent, elliptical, adhesive pad composed of thickly-crowded, long, cylindrical, ectodermal cells. Beyond this adhesive pad the tip bends sharply at an angle with the main shaft of the tentacle.

On the margin, close to the base of the velum, there are basal bulbs which correspond both in number and position to the exumbrella tentacles. These basal bulbs are believed by Goto to be homologous with the flexible, hollow, marginal tentacles of *Olindias* and *Olindioides*. Their ectoderm is clogged with developing nematocysts, and their entoderm consists of simple, hollow prolongations of the cavity of the ring-canal. There is a pair of lithocysts, each with one concretion at the base of each of the exumbrella tentacles. The lithocysts are thus twice as numerous as the tentacles. They are small, closed vesicles, buried in the gallert near the outer nerve-ring on the outer side of the ring-canal.

The manubrium is quadrate, without a peduncle, and has 4 simple, unfringed lips which are at about the level of the velar opening. There are 4 radial-canals and a simple ring-canal without centripetal diverticula. The 4 gonads are developed upon nearly the entire lengths of the 4 radial-canals and are simple, linear thickenings which, being longer than the canal upon which they develop, are sinuously folded from side to side of the axial line of the radial-canal. This medusa may eventually prove to be identical with *G. agassizii* (see fig. 198.)

The radial-canals, basal bulbs, and adhesive disks of the tentacles are translucent chestnut brown. Tentacles, gonads, circular canal, and the larger part of manubrium are lighter brown. Mouth pale-green. At the base of each tentacle there is a speck of brilliant emerald-green.

Found among the eelgrass around the wharves of Yokohama, Japan. Its habits appear to be identical with those of *G. murbachii*. It is beautifully figured and elaborately described by Goto.

Gonionemus suvaensis Agassiz and Mayer.

Gonionemus suvaensis, Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 164, plate 5, figs. 14–16.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 27, p. 107, plates 3 and 32.
Gonionemus pelagicus, Bigelow, H. B., 1904, Bull. Mus. Comp. at Harvard College, vol. 39, p. 256, plate 4, figs. 12–14.

Bigelow, 1909, whose opportunities for the study of the Pacific species of *Gonionemus* far exceeded those of any other observer, has decided that *G. suvaensis*, *G. pelagicus*, and *G. hornelli* are only local varieties of one and the same species of medusa which is characterized by having but 16 lithocysts and by its gonads being confined to short lengths on the outer ends of its radial-canals.

Bell 8 to 20 mm. wide, flatter than a hemisphere, with only moderately thick walls. About 50 to 80 stiff, sucker-bearing tentacles not quite as long as the bell-radius. These tentacles all project from the exumbrella side of the margin and their distal tips bend sharply at right angles to shaft of tentacle. 16 freely projecting marginal lithocysts, each containing a single concretion; 4 of these lithocysts in each quadrant. Velum well developed. There are 4 straight radial tubes, upon the lower portions of which, near to the circular tube, the gonads are situated. The gonads are folded in a sinusoidal curve alternately to the right and left of the radial tube, resembling those of *Gonionemus murbachii*. Manubrium cruciform in cross-section, the lips prominent.

Green pigment-spots are found in the ectoderm of the basal bulbs of the tentacles and upon the radial tubes close to their junction with the stomach. Entoderm of radial tubes in region of gonads tinged with green. The ectoderm of bell-margin is of a delicate rose-color, manubrium and gonads brown in specimens from the Fiji Islands, but in Bigelow's medusæ from Suvadiva Atoll, Maldive Islands, Indian Ocean, the manubrium and tentacles were yellowish-green, with Vandyke-brown pigment at the bases of the tentacles. Gonads rose-pink. In 12 specimens found by Bigelow in Mangareva Harbor, Paumotos Islands, the tentacles and tentacle-bulbs are pale yellowish, without green pigment, and the gonads brownish-red. (See text-figures 199 and 200.)

The medusa is evidently widely distributed, although only locally abundant, and may be considered as the tropical Pacific *Gonionemus* where it occurs in coral lagoons or in the sea near land.

This medusa was common in Suva Harbor, Fiji Islands, late in December, 1897.

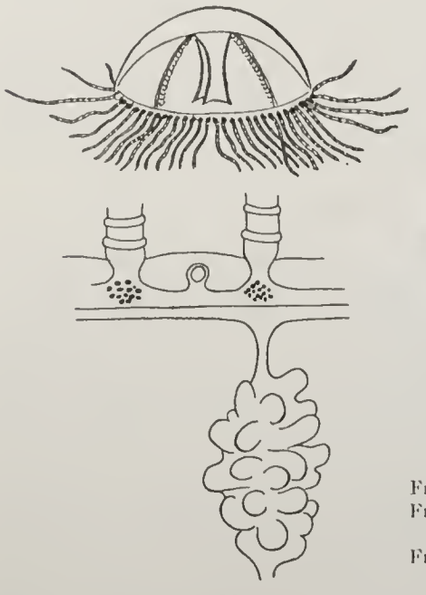
Gonionemus "hornelli" Browne=G. suvaensis.

Gonionemus hornelli, Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Suppl. Report No. 27, Roy. Soc. London, p. 149, plate 1, fig. 6; plate 2, fig. 4.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 106.

Bigelow has decided that the apparent grouping of the tentacles in this medusa is due solely to the 16 lithocysts which divide the tentacles into 16 linear groups, in no sense comparable with the tentacle-clusters of *Gossea*. He concludes, therefore, that this medusa is actually *G. suvaensis*. I present Browne's clear description herewith, for this was in proof before the appearance of Bigelow's excellent paper upon the medusæ of the eastern tropical Pacific, and it will serve as a means of reference to the medusa.

Bell hemispherical, 6 mm. wide, with moderately thick walls. About 70 tentacles, all with adhesive pads on their exumbrella sides near middle of lengths where the tentacles are contracted. These tentacles are about equally spaced around the margin, but are arranged in 16 groups in accordance with size. The 16 radial, adradial, and interradial tentacles are long and the remainder are smaller, those nearer the long tentacles being longer than the tentacles farther away. The radial and interradial groups contain each about 5 tentacles, and the adradial clusters only about 4 tentacles. This tendency toward grouping exhibited by

198.



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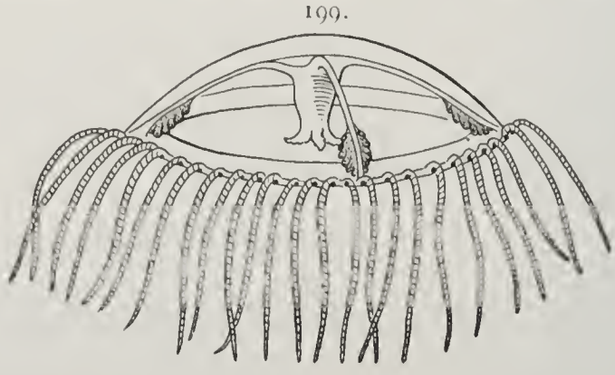

200.

Fig. 198.—*Gonionemus depressus*, after Goto, in Mark Anniversary Volume.
Fig. 199.—*Gonionemus suvaensis*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.
Fig. 200.—Bell-margin of *Gonionemus suvaensis*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.

the tentacles recalls the condition seen in *Gossea*, but is not so well marked. The tentacles all project from the exumbrella sides of the margin, their entodermal cores piercing the gallert. The tentacles are profusely ringed with nematocysts. There is a globular marginal bulb at the base of each tentacle. There are 16 lithocysts on the subumbrella side of the margin, between the 16 groups of tentacles, adjacent to the circular canal. Velum fairly broad. 4 broad radial-canals. Stomach cruciform, mounted upon a short, broad, conical peduncle. 4 short, simple lips. The gonads are developed upon the distal ends of the radial-canals very near the circular canal. They are small, deeply folded and lobed, and extend laterally on both sides of the canals, so that they are about twice as wide as they are long. The ova are large. Pearl Banks, Gulf of Manaar, between Ceylon and India. A single specimen was studied by Browne.

Genus CUBAIA Mayer, 1894.

Cubaia, Mayer, 1894, Bull. Museum Comp. Zool., vol. 25, p. 237; *Ireniopsis*, *Ibid.*, p. 238; 1904, Mem. Nat. Sci. Brooklyn Inst. Museum, vol. 1, No. 1, p. 19.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 102.
Gonionemoides, Mayer, 1900, *Ibid.*, vol. 37, p. 62.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 738.

The type species is *Cubaia aphrodite*, of Cuba, the Bahama and Florida reefs.

Plate 47.

Figs. 1 to 3. *Cubaia aphrodite.* Successive stages in the growth of the medusa. Figure 1, one mm. in diameter; figure 3, mature medusa 11 mm. wide. Nassau Harbor, Bahamas, June, July, 1903.

Fig. 4. *Cubaia aphrodite.* Side view of the manubrium of the medusa shown in figure 3.

Fig. 5. *Cubaia aphrodite.* One of the marginal lithocysts.

Figs. 6 and 7. *Cubaia aphrodite.* Tentacles of a mature medusa. Figure 6, one of the marginal tentacles, figure 7, one of the "sucker" bearing exumbrella tentacles.

Figs. 8 to 10. *Olindias tenuis.* Successive stages in the growth of the young medusa. Figure 8 with bell less than 1 mm. wide; figure 9 with bell 4 mm. high; figure 10 with bell 8 mm. wide, medusa still immature, but with the marginal tentacles beginning to develop.

Drawn from life, by the author.

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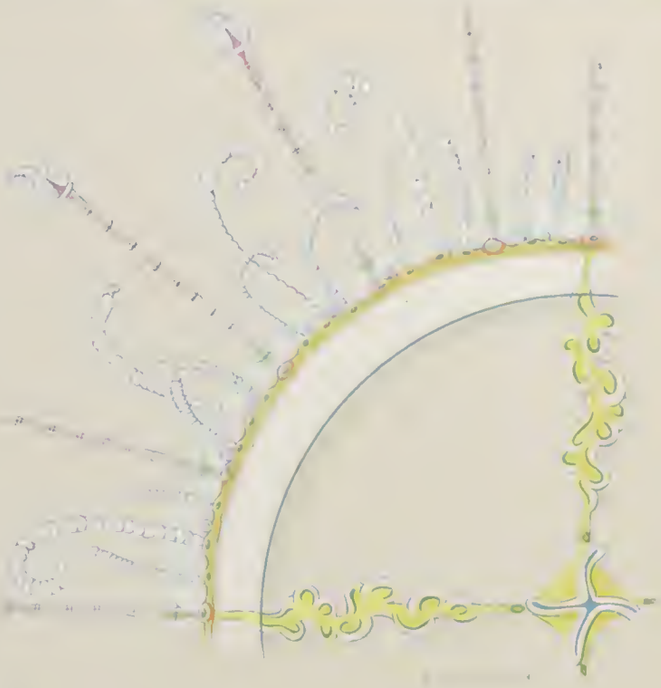

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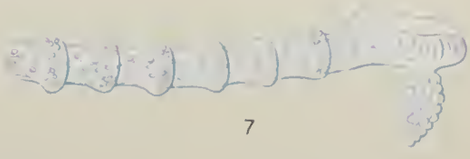

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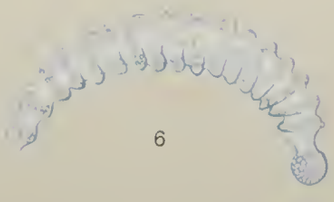

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GENERIC CHARACTERS.

Olindiadæ similar to *Gonionemus*, but with tentacles of two sorts, one set arising from the sides of the exumbrella above the margin and the other set arising from the bell-margin. Lithocysts projecting outward as in *Gonionemus*. No centripetal canals. 4 radial-canals, 4 gonads, 4 lips.

This genus is closely related to *Vallentinia* Browne, 1902, but in *Vallentinia* the lithocysts are inclosed and on the inner side of the margin, whereas in *Cubaia* they are external and on the lower side of the margin between the tentacles.

Cubaia differs from *Olindias* in that there are no centripetal canals.

These medusæ are found in shallow water over coral flats in the Bahamas and off the Florida Reefs. In habits they closely resemble *Gonionemus*.

Cubaia aphrodite Mayer.

Plate 46, fig. 6; plate 47, figs. 1 to 7.

Cubaia aphrodite, Mayer, 1894, Bull. Museum Comp. Zool. at Harvard College, vol. 25, p. 237, plate 2 figs. 1–3; 1904, Mem. Nat. Sci. Brooklyn Inst. Museum of Arts and Sci., vol. 1, No. 1, p. 21, plate 5, figs. 43–49.
Gonionemoides geophila, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 62, plates 3–5, figs. 6–11.
Ireniopsis primordialis (young medusæ, green variety), Mayer, 1894, Bull. Mus. Comp. Zool. at Harvard College, vol. 25, p. 238, plate 1, figs. 3–6.

Mature medusa (plate 47, fig. 3).—Bell slightly flatter than a hemisphere and about 12 mm. in diameter. About 80 tentacles, of which about 20 project from the sides of the bell in a zone above the bell-margin (plate 47, fig. 7), their entodermal cores extending through the gelatinous substance of the bell to the ring-canal. These tentacles are ringed at regular intervals with about 8 nodular swellings containing nematocysts. On the aboral side, near outer end of each tentacle, there is a large adhesive disk, while beyond this the short, tapering extremity of the tentacle bends at a right angle to the main shaft. This extreme tip of the tentacle bears a large grape-like cluster of nematocyst-cells.

The remaining 50 to 60 tentacles arise from the bell-margin (plate 47, fig. 6), at a lower level than the zone of origin of the adhesive tentacles. They are somewhat flexible and project downward rather than outward. They have no adhesive disks, but are provided with 25 to 30 rings of nematocysts and terminate each in a knob-like cluster of nettling cells.

There are about 35 closed, vesicular lithocysts, each containing a single spherical concretion and all arising from the bell-margin close to the bases of the marginal (non-adhesive) tentacles; they project downward freely into the water. The cyclical order of appearance of tentacles and lithocysts is identical with that in *Gonionemus* described on pages 345 and 346. Velum well-developed. The circular vessel is simple and narrow and without centripetal diverticula. There are 4 straight, narrow radial-canals, upon the mid-regions of which are the papilliform, reflected gonads. Manubrium flask-shaped; 4 simple, cruciform lips.

The entoderm of the manubrium, gonads, and circular canal is dull rosin-yellow. There are 4 green, entodermal pigment-spots on the manubrium near the points of origin of the 4 radial-canals. The internal entoderm of the bases of the adhesive tentacles is rich magenta-purple, while an intense green color extends a short distance outward into the entodermal shaft of the tentacle. The bases of the non-adhesive tentacles are dull-green without the magenta color. In some specimens the magenta color is absent. The gonads sometimes display scattered, dark-colored pigment-granules. This medusa is very active, swimming rapidly with a few powerful pulsations and then slowly sinking down with tentacles outspread. It often attaches itself to objects by means of its adhesive disks.

Development of the medusa.—When 1 mm. in diameter (plate 47, fig. 1) the bell is higher than a hemisphere and the exumbrella surface regularly sprinkled with nematocysts. There are 16 tentacles. The radial and interradial tentacles have as yet no adhesive disks but terminate in simple nematocyst-knobs. The 8 intermediate tentacles, however, have such disks. There are only 4 lithocysts at this stage and the manubrium is rudimentary.

When 6 mm. in diameter (plate 47, fig. 2) the bell is hemispherical. There are about 20 sucker-bearing tentacles alternating with an equal number of nematocyst-bearing ones,

12 lithocysts and a flask-shaped manubrium. The 4 gonads, which begin to develop upon the 4 radial-canals at the corners of the manubrium, have now migrated down the radial-canals, although still small and immature. In mature medusæ the 4 gonads are found upon the middle or outer two-thirds of the 4 radial-canals, but they do not extend to the circular vessel. The gonads are longer than the parts of the canals upon which they develop and are therefore reflected from one side to the other of the canal, finally developing hernia-like evaginations and becoming papilliform.

This medusa is abundant on the Bahama flats and along the Florida Reefs, and a study of large numbers of specimens convinces me that *Cubaia aphrodite* and "*Gonionemoides geophila*" are only different stages and color varieties of one and the same medusa, and that I was mistaken in attempting to separate them. The green variety is shown in plate 46, fig. 6.

Genus VALLENTINIA, Browne, 1902.

Vallentinia, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 283.—Mayer, 1904, Memoirs Nat. Sci. Brooklyn Institute Museum, vol. 1, p. 20.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 738.

GENERIC CHARACTERS.

Olindiadæ with 4 simple radial-canals and without blindly ending, centripetal canals. Some of the tentacles are solid, arise from the sides of the bell, and are provided with "suckers." The remaining tentacles are hollow, arise from the bell-margin and have bands of nematocysts. The lithocysts are inclosed and adjacent to the ring-canal, on the inner side above the velum. The gonads are oval and sac-like.

The type species is *Vallentinia falklandica* described by Browne from Stanley Harbor, Falkland Islands. Browne studied a single specimen of small size. His description is brief and unaccompanied by figures, and I suspect that this may prove to be an immature stage of some *Olindias*.

Vallentinia falklandica Browne.

Vallentinia falklandica, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 284.—Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, Medusen, p. 19, Anvers.

Umbrella bell-shaped, 3 mm. high, 2 mm. wide. 4 solid perradial tentacles with terminal suckers and 24 hollow tentacles, 6 in each quadrant, uniformly distributed. These 24 tentacles are covered with bands of nematocysts. There are 16 inclosed lithocysts, each with a single concretion. Stomach short, about one-third the length of bell-cavity, not situated upon a peduncle. Mouth with 4 (?) lips. Gonads oval, sac-like, and situated on 4 radial-canals in the upper half of the bell-cavity, a short distance below the stomach. A single specimen is described by Browne from Stanley Harbor, Falkland Islands, where it probably lives among the fronds of kelp. This is probably an immature form and may possibly be a young *Olindias (?)*.

Genus OLINDIAS F. Müller, 1861.

Olindias, Müller, F., 1861, Archiv. für Naturges., Jahrg. 27, p. 312.—Haeckel, 1879, Syst. der Medusen, p. 252.—Ostroumoff, 1896, Zool. Anzeiger, p. 30.—Goto, 1903, Mark Anniversary Volume, p. 14.—Bigelow, 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 259; Mem. *Ibid.*, 1909, p. 108.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 736; 1905, Report Pearl Oyster Fish., Gulf of Manaar, pp. 150, 151.—Mayer, 1904, Mem. Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, p. 20.—Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 47.
Halicalyx, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 277.—Mayer, 1900, *Ibid.*, vol. 37, p. 63.
Vallentinia (immature medusa?), Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 284.

The type species is *Olindias sambaquiensis* F. Müller, of the coast of Brazil. This is closely related to, if not identical with, *O. tenuis* of the Florida Reefs and Bahama Islands.

GENERIC CHARACTERS.

Olindiadæ with 2 sorts of tentacles, one arising from the bell-margin and the other set projecting from the sides of the bell above the margin. The tentacles bear adhesive pads. Lithocysts between the tentacles, inclosed on the inner side of, and above, the margin. 4 radial-canals. Numerous centripetal vessels. 4 lips. 4 papilliform, sinusoidally reflected gonads upon the radial-canals.

The medusæ of *Olindias* are all tropical forms living near shores, usually in the relatively impure water of harbors or over muddy coral flats. An important series of tabulated observations upon this genus has recently been published by H. B. Bigelow, 1909.

Synoptic Table of the Species of Olindias.

	O. malayensis Maas, 1905.*	O. tenuis Fewkes, 1882; Browne, 1904; Mayer, 1900, 1904; Bigelow, 1909.	O. phosphorica = O. mülleri Delle Chiaje, 1841; Haeckel, 1879; Goto, 1903.	O. sambaquiensis F. Müller, 1861.	O. singularis Browne, 1904.†
Diameter in mm. and shape of bell when mature.	Higher than a hemisphere, 25 to 35.	35. Hemispherical.	Flatter than a hemisphere, 40 to 60; 50, Goto. It may become mature when only 28 mm. wide.	Flatter than a hemisphere, 50 to 100 wide, 20 to 30 high.	13 to 36. Hemispherical.
Number of primary tentacles arising from exumbrella.	20 to 30. Provided with adhesive pads.	32 to 54. Provided with adhesive pads.	50 to 109. Provided with adhesive pads.	80 to 100	28 to 86. No adhesive pads.
Length of primary tentacles in terms of bell-radius (*r*).	*r*, thick	*r*, thin.	*r*.	*r*.	*r*.
Number of secondary tentacles arising from lower side of bell-margin.	30 to 40. No suckers only terminal nematocyst-knobs.	38 to 70±. Provided with weak adhesive pads.	35, Goto; 100 to 120, Haeckel.	200 to 300	16 to 50
Length of secondary tentacles, when extended, in terms of bell-radius (*r*).	±*r*, thin.	8 *r*, thick.	8 *r*±	8 *r*±	*r*+
Number and shape of papillæ or club-shaped appendages of bell-margin.	120. Club-shaped. Mounted on narrow stalks.	64 to 69. Bluntly rounded with wide bases. Some finally develop into secondary tentacles.	100 to 170. Club-shaped with narrow bases. They develop into secondary tentacles, Goto.	100 to 200. Club-shaped. They develop into secondary tentacles, F. Müller.	32 to 104. Globular.
Number and position of lithocysts.	40 to 60, pair at base of each primary tentacle.	64 to 108. Arranged as in O. malayensis.	100 to 120. Arranged in pairs at bases of 50 to 60 primary tentacles, as in O. tenuis, and O. malayensis.	160 to 200. Arranged as in O. malayensis.	28 to 90. One at base of each primary tentacle.
Number of blindly ending centripetal canals which arise from ring-canal in each quadrant.	7 to 9	7 to 10	11 to 19	21 to 27	4 to 12
Form and position of gonads.	Linear, swollen, with papilliform processes on nearly entire lengths of 4 radial-canals.	Linear, with papilliform processes on outer halves of 4 radial-canals.	Linear, swollen, with surfaces covered with branched processes; gonads extend over nearly entire length of radial-canals.	On almost entire lengths of 4 radial-canals, gonads bear branched, tree-like projections.	On outer halves of 4 radial-canals. Papilliform, with branching, tree-like processes.
Color.	Quite like that of O. phosphorica.	Entoderm of manubrium, tentacle-bulbs, and gonads opaque yellowish-green, streaked with purple. Nematocyst clusters on exumbrella tentacles white or dark-purple and those on marginal tentacles are red and yellow.	Colors quite similar to those of O. tenuis, but apparently browner and duller. I have seen only preserved specimens of O. phosphorica.	Bright and variable, with mingled yellow, red, brown, and black. Colors quite similar to those of O. tenuis.	Entoderm of stomach, gonads, and ring-canal opaque (cream color ?).
Where found.	Malay Archipelago, in harbors and on the surface.	Bahamas, Florida, and Bermuda. In shallow water over coral flats, in spring and early summer.	Mediterranean. Naples, August to November.	Coast of Brazil, Sambaqui, Santa Catharina Island. Common on surface on calm winter days.	Suvadiva Atoll, Maldive Islands, Indian Ocean.

*Maas, 1905, regards *O. malayensis*, *tenuis*, and *sambaquiensis* as varieties of *O. phosphorica*. He points out the fact that gonads in *O. sambaquiensis* appear to become mature only when the medusa is larger and has more marginal appendages than in other varieties of *Olindias*. He would arrange varieties in series beginning with *O. malayensis*, which becomes mature with least number of tentacles, etc., through *O. tenuis*, *phosphorica*, and finally *sambaquiensis*.

†This species is distinguished by unpaired lithocysts.

Olindias sambaquiensis F. Müller.

Olindias sambaquiensis, Müller, 1861, Archiv. für Naturges., Jahrg. 27, p. 312, taf. 9.—Haeckel, 1879, Syst. der Medusen, p. 254.

Olindias sambaquensis, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 48.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 109.

Bell 50 to 100 mm. wide and 20 to 30 mm. high. 80 to 100 stiff, hollow tentacles arising from sides of bell, slightly above margin; these are not quite as long as bell-radius and arise in the radii of the radial and centripetal canals. There are also 200 to 300 very flexible, long, hollow tentacles which arise from the bell-margin and are 3 to 6 times longer than bell-diameter. 100 to 200 club-shaped, marginal projections, some of which develop into flexible tentacles. 160 to 200 paired lithocysts at bases of the stiff tentacles. Velum well developed. Stomach is 4-sided, narrow, and prismatic, almost as long as bell-radius. 4 simple lips. 4 complete radial-canals, and as many as 108 blindly ending, centripetal canals, 27 in each quadrant. The gonads cover nearly the entire lengths of the 4 radial-canals. Each gonad is swollen and linear and has 20 to 40 tree-like, branching processes over its surface when mature.

Color bright and variable with mingled yellow, greenish-yellow, red, brown, and black; canal-system red.

This species is found near shore off the west coast of the Island of Santa Catharina at Sambaqui, off the coast of Brazil, and is abundant upon the surface during calm days in winter. It is distinguished from *O. tenuis* mainly by its greater number of blindly ending, centripetal canals. There are as many as 27 such canals in each quadrant in large medusæ of *O. sambaquiensis*, while there are only 7 to 10 in *O. tenuis*. These centripetal vessels increase in number as the medusa grows in size.

The best description is that of F. Müller, the only naturalist who has seen the medusa. *O. tenuis* is probably only a small, northern variety of *O. sambaquiensis*.

Olindias tenuis Browne.

Plate 47, figs. 8 to 10; plate 48, figs. 1 to 7.

Halicalyx tenuis, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, p. 277, plate 7, fig. 15.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 63, plates 5, 6, figs. 12, 13.—Goto, 1903, Mark Anniversary Volume, p. 15.

Olindias tenuis, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 737.—Mayer, 1904, Mem. Nat. Sci. Brooklyn Inst. Museum, vol. 1, p. 23, plates 5, 6, figs. 50–59.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 109.

Mature medusa.—Bell hemispherical, 35 mm. in diameter. Gelatinous substance quite rigid. About 90 to 150 tentacles. 32 to 54 of these are straight, about one-third as long as the bell-diameter, and arise from the sides of the bell in a zone at a short distance *above* the margin. These tentacles are besprinkled with wart-like clusters of nematocysts and near their outer ends, on the aboral side, one finds an elongate, pad-like cluster of nematocyst-cells (plate 48, fig. 4), having a sucker-like appearance, which actually functions as a powerful organ of adhesion, enabling the medusa to anchor itself to stones, seaweed, etc. Besides the short, straight tentacles there are about 40 to 60 others, very flexible and often coiled in close helices; when extended, these tentacles are about 4 times as long as bell-diameter; they arise from the *bell-margin*, *below* the zone of projection of the straight tentacles. A powerful strand of longitudinal muscle fibers extends throughout the entire length of the inner (velar) side of each of these marginal tentacles, while half-rings of nematocysts are found at regular intervals upon their outer sides (plate 48, figs. 5 and 6).

The tentacles are thus comparable in their structure to the long ones of *Physalia*. They terminate in a knob-like cluster of nematocysts and upon their inner (axial) sides, near the distal end, there is a flat, pad-like cluster composed of very elongate and thickly crowded ectodermal cells which occasionally serves as a weak organ of adhesion. In addition to the tentacles there are about 64 to 69 bluntly rounded papillæ upon the bell-margin, between the tentacles. There are 64 to 108 lithocysts on the inner side of, and above, the ring-canal, a pair on either side of the origin of each and every one of the short, straight tentacles. Each lithocyst contains a single spherical concretion. There are 4 straight, narrow radial-canals and 28 to 40 diverticula, which extend inward from the circular vessel and end blindly in the

Plate 48.

Fig. 1. *Olindias tenuis*, mature medusa. Nassau Harbor, Bahamas, July 16, 1903.

Figs. 2 to 4. *Olindias tenuis*. Successive stages in the development of the adhesive pads on the aboral sides of the exumbrella tentacles in medusæ, the diameter of whose bells are 2 mm., 8 mm., and 16 mm. respectively.

Fig. 5. *Olindias tenuis*, side view of a part of one of the marginal tentacles showing the half rings of nematocysts upon the exumbrella (aboral) side, and the strand of longitudinal muscles on the inner (velar) side of the tentacle.

Fig. 6. *Olindias tenuis*. The extremity of one of the long marginal tentacles showing the pad-like mass of adhesive cells and the knobbed end of the tentacle.

Fig. 7. *Olindias tenuis*. View of one of the gonads.

Drawn from life, by the author.

2
7
3
4
5
6

gelatinous substance of the bell. The lithocysts flank the sides of these radial-canals and diverticula. The 4 gonads are papilliform and reflected from side to side, and are developed upon the outer halves of the 4 radial-canals (plate 48, fig. 7). Manubrium tubular, cruciform in cross-section and elongate, with 4 recurved lips; it extends about three-quarters of the distance from inner center of bell-cavity to velar opening.

The gelatinous substance of the bell is of a delicate greenish-yellow. The entoderm of the manubrium, gonads, and tentacle-bulbs is opaque yellow-green, with the innermost parts purple. There are 4 interradial, reddish-purple pigment-spots upon the manubrium near the points of origin of the radial-canals. The nematocyst-warts upon the short, exumbrella tentacles are either white or dark-purple, while the half-rings on the long, flexible, marginal tentacles are red and yellow.

Development of medusa (plate 47, figs. 8 to 10).—The youngest medusæ observed were about 0.7 mm. in diameter, the bell being higher than a hemisphere and the exumbrella surface regularly besprinkled with nematocysts. There were 8 tentacles, 4 radial and 4 interradial, all belonging to the short, straight, exumbrella set and projecting from sides of bell above bell-margin. Only 4 lithocysts, one at base of each interradial tentacle. Radial-canals narrow and straight-edged; the circular vessel simple, without centripetal diverticula. Manubrium quadratic and very short.

As the medusa grows, its bell increases in height relatively faster than in width, so that it becomes higher than a hemisphere and resembles in shape the bell of *Bougainvillia*. When 3 mm. high there are still only 8 tentacles, but the radial-canals have become broad with serrate edges and 4 interradial diverticula begin to develop from the circular vessel. The 8 tentacles have greatly elongated and terminate in simple nematocyst-knobs. When the medusa is 8 mm. in diameter 16 of the tentacles project from the sides of the bell and about an equal number of the flexible, coiled tentacles arise from the bell-margin. 32 lithocysts, a pair on inner side, above the velum and flanking each of the 16 tentacles arising from sides of bell. There are now 3 blindly ending, centripetal canals that arise from the ring-canal in each quadrant. The gonads have not yet made their appearance. The tentacles that arise from the sides of the bell have begun to develop their peculiar pad-like disks upon their aboral sides. These pad-like disks, which are evidently homologous with the adhesive disks in *Gonionemus* and *Cubaia*, are developed from the aboral side of the primitive nematocyst-knobs of the tentacles, as is shown in successive stages represented in plate 48, figs. 2 to 4. We see, then, that the youngest medusa of *Olindias* may be said to be in the "*Gonionemus* stage," for it has only tentacles of the exumbrella set and the circular canal is simple and without diverticula. It seems probable, therefore, that *Olindias* is descended from a Gonionemus-like medusa. The stiff, exumbrella tentacles are therefore primitive, while the flexible marginal tentacles are secondary.

Olindias tenuis is one of the few medusæ that thrive best on the shallow flats of the Bahamas, Bermudas (Bigelow), and Florida coast, and is very abundant during the summer months in Nassau Harbor, and at Key West, Florida. It appears to become mature with fewer centripetal canals and tentacles, and when of smaller size than *O. sambaquiensis* of Brazil. We must bear in mind, however, that it may be only a small northern variety of *O. sambaquiensis*.

Bigelow, 1909, gives the best modern description of this medusa.

Olindias phosphorica Haeckel.

Oceania phosphorica, Delle Chiaje, 1841, Mem. sulla storia degli animali senza vertebrati, Napoli, tome 5, p. 131, plate 147, figs. 1–3.

Thaumantias punctata, Spagnolini, 1876, Catalogo Acalefi Mediterraneo, p. 26, tav. 4, fig. 1.

Olindias phosphorica, Haeckel, 1880, Syst. der Medusen, p. 654; *Ibid.*, 1879, p. 253, taf. 15, figs. 9–13 (*Olindias mülleri*).—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 48.

Olindias mülleri, Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 359.—Goto, 1903, Mark Anniversary Volume, p. 14.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 737.—Bethe, 1903, Allgemeine Anatomie und Physiol. Nervensystem, p. 419 (effects of chemicals on pulsation)—Stschelkanowzeff, 1905, Nachricht. Gesell. Freunde Natur. Moskau, Bd. 110, p. 42, taf. 45, fign. 1–31; 1906, Zoolog. Centralblatt, Bd. 13, p. 679 (anatomy and histology).—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 109.

This species is found in the Mediterranean. It is best described by Haeckel, Bigelow, and Goto. Delle Chiaje and Haeckel present good figures of the medusa. It is sometimes

quite abundant at Naples upon the bottom in deep water in October and November, but is not found in winter. Graeffe finds it at Rovingo and Piramo, Adriatic, from October to February. For description, see the synoptic table of the species of *Olindias*.

The red-colored "ocelli" described by Haeckel are actually excretion pores. According to Stschelkanowzeff, the concretions are of entodermal origin and are innervated by the upper nerve-ring. Crystals are found in the entoderm of the ring-canal. The large, oval nettle-cells are associated each with a ganglion-cell, which sends out a network of fibers over the nettle-cell. The nettle-cell is mounted upon an elastic pad. The radial-canals are entwined by a spiral (helical) entodermal musculature.

FIG. 201.—*Olindias malayensis*, after Maas, in Ergeb. *Siboga* Expedition, Hydromedusen.

According to Bethe, 1903, if the medusa be paralyzed by removing its bell-margin, pulsations will recommence if the bell be placed in pure NaCl. An excess of 0.25 to 1 per cent of KCl added to the sea-water causes temporary pulsation in the paralyzed bell of *Olindias*, but the final effect of potassium is depressive, the initial stimulus being only momentary.

Bethe shows that in such medusæ as *Olindias*, *Geryonia*, *Cotylorhiza*, and *Rhizostoma*, the pulsating tissue displays a refractory period such as was demonstrated by Marey, 1876, in the vertebrate heart. During the period of systole an electrical stimulus has no effect, but only during the period of diastole does such a stimulus produce an extra contraction, and the latent period preceding this extra contraction is shorter the later the stimulus is applied in the diastolic phase. This applies to the medusæ, however, only when at normal temperatures, for at temperatures much higher than the normal the medusa can be stimulated even when in systole.

Bethe shows that the refractory state is a property of the nerves, not of the muscles, for the pulsation-stimulus is nervous in nature. On the other hand the latent period (*i. e.*, the time which elapses between the reception of the stimulus and the muscular contraction) is a property of the muscles.

Olindias malayensis Maas.

Olindias phosphorica, DELLE CHIAJE; nov. var. *malayensis*, MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 47, taf. 9, fign. 60, 61.

The distinguishing characteristics of this form are its thick gelatinous walls, high, rounded bell, and the thickly crowded, very elongate, club-shaped papillæ of its gonads. The gonads are mature when the medusa has fewer marginal appendages than *O. phosphorica* of the Mediterranean or *O. sambaquiensis* of the coast of Brazil. It is distinguished from *O. tenuis* of the Bahamas and Florida by its numerous marginal clubs, which have swollen ends and narrow necks.

The disk is 25 to 35 mm. wide. 20 to 30 "primary" tentacles project out from the exumbrella side of the margin; these have club-shaped outer ends and are provided with adhesive disks as in *Gonionemus;* their shafts are covered with partial rings of nematocysts, which are spaced at fairly regular intervals. These primary tentacles are relatively non-contractile and are thicker than the secondary tentacles. A pair of lithocysts is found at the base of each of the primary tentacles. These are inclosed in the gelatinous substance of the bell and each contains a single, large, spherical concretion. The secondary tentacles arise from the lower side of the bell-margin and are smaller and more contractile than the primary tentacles. There are 1

to 3 of these secondary tentacles between each successive pair of primary tentacles. Their nematocyst-rings are more nearly complete than in the primary tentacles, and each ends in a simple knob of nematocysts, without a terminal sucker. The marginal knobs are club-shaped, with swollen ends and narrow flask-like necks, and they are 2 to 4 times as numerous as the primary tentacles. There are 4 main radial-canals 90° apart and 7 to 9 straight, simple, blindly ending centripetal canals in each quadrant. Gonads are developed upon nearly the entire lengths of the 4 radial-canals and consist of a cluster of thickly crowded, thin, elongate, club-shaped papillæ in the males; but these papillæ are not so prominent in the females, the ovaries having more the appearance of folded bands.

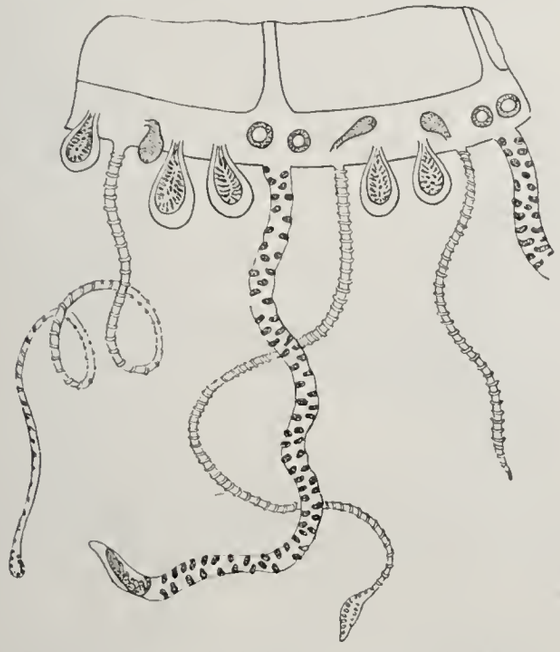


FIG. 202.—Bell-margin of *Olindias malayensis*, after Maas, in Ergeb. *Siboga* Expedition, Monog. 10.

The colors, although apparently decided, could not be determined in the preserved specimens studied by Maas.

The medusa is common on the surface in the harbors of the Malay Archipelago, at Labuan Badjo, Flores; at Tongkil; at Saleyer; and between Gebé and Fau.

Maas calls attention to the close relationship between the Mediterranean, Atlantic, and Pacific species of *Olindias*, and considers *O. phosphorica* (*mülleri*), *O. malayensis*, *O. tenuis*, and *O. sambaquiensis* to be more nearly varieties one of the other than distinct species. This view is probably correct and might be extended to dozens of other races of medusæ of such genera as *Sarsia*, *Turris*, *Æquorea*, *Liriope*, *Aglaura*, *Aurelia*, etc. Many of our so-called species must be only geographical varieties or races of widely distributed forms, and the great advance in systematic studies of medusæ will come in future from a comparison of reared specimens from numerous localities over the world. Such studies will probably reduce rather than increase the number of "species" of medusæ.

Olindias singularis Browne.

Olindias singularis, BROWNE, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 737, plate 56, fig. 2; plate 57, fig. 1.—MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10 p. 48.—BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 109, plates 4, 31, and 32.

This species differs from others of the genus in that there is but a single lithocyst at the base of each primary tentacle instead of a pair of lithocysts as in other species of *Olindias*.

Bell hemispherical, 13 to 36 mm. wide. Gelatinous substance thick. There are 28 to 86 primary tentacles. These all project from exumbrella side of margin, have oblong or short spiral rings of nematocysts, and are stiff and not quite as long as the bell-radius. Their ends bear "claw" shaped adhesive pads. There are 4 to 12 secondary tentacles in each quadrant. These are flexible and ringed with partial rings of nematocysts. These secondary tentacles are hollow, longer, and thicker than the primary tentacles and arise from the lower side of the bell-margin. There are about 8 to 25 globular marginal bodies in each quadrant; these contain nematocysts. There is a single internal vesicle, containing one concretion, at the base of each primary tentacle. 4 radial-canals and 4 to 12 blind, centripetal canals arise from the ring-canal in each quadrant. Stomach about half as long as depth of bell-cavity; it is a 4-sided, narrow prism with 4 well-developed lips with sinuous edges. The gonads are papilliform clusters upon the outer half of each of the 4 radial-canals.

Found at Suvadiva, Maldive Islands, Indian Ocean, and Mangareva, Paumotos Islands.

Browne states that he observed no "suckers" upon any of the tentacles, but in *Olindias tenuis* Bigelow and I find that these are present and are functional, although on account of their small size and elongate form they are difficult to observe in preserved specimens.

Living medusæ of *O. tenuis* frequently anchor themselves with much tenacity. There is, however, much variability in the degree of development of suckers upon some or all of the tentacles in the various species of Olindiadæ. This is well shown by comparing the figures given by Maas, 1905, of the distal ends of the secondary tentacles of *O. malayensis*, with those of *O. tenuis* given by Mayer, 1904. Bigelow, 1909, who found 12 specimens of this medusa in Mangareva Harbor, Paumotos, tropical Pacific, states that all of the tentacles bear terminal, adhesive pads. He finds that the medusa closely resembles *O. tenuis*, excepting for the fact that there is commonly but one lithocyst at the base of each primary tentacle. A few lithocysts contain, however, 2 spherical concretions. Bigelow states that the medusa is colorless, except for the gonads, which are reddish-brown to brick-red.

He found an abnormal medusa with 2 manubria and 9 gonads, 4 of which were upon the radial-canals and 5 on the centripetal vessels.

Genus OLINDIOIDES Goto, 1903.

Olindioides, Goto, 1903, Mark Anniversary Volume, article 1, pp. 3, 19.—Mayer, 1904, Memoirs Nat. Sci. Museum Brooklyn Inst. Arts and Sci., vol. 1, p. 20.

The type species, and only known form, is *Olindioides formosa* Goto, of the Bay of Tokyo, Japan.

GENERIC CHARACTERS.

Olindiadæ with 6 radial-canals, numerous blindly ending, centripetal canals, and two sorts of tentacles. Of these, the exumbrella tentacles project at various levels from the sides of the bell above the margin and bear adhesive pads. The velar or marginal appendages consist of rudimentary tentacle-bulbs and elongated nematocyst-bearing tentacles. There are 2 inclosed lithocysts at the base of each exumbrella tentacle. Development unknown.

Olindioides formosa Goto.

Olindioides formosa, Goto, 1903, Mark Anniversary Volume, article 1, p. 3, plate 1, figs. 1–9; plate 2, figs. 14–16; plate 3, figs. 17–20.

Bell of adult medusa nearly hemispherical; that of young medusa somewhat higher than a hemisphere. When adult the bell is about 75 mm. wide, being widest slightly above the margin. Gelatinous substance thick and very consistent. There are two sorts of tentacles. One kind arises from the velar margin and may be called velar tentacles; the tentacles of the other sort project outward from the exumbrella above the margin and may be called exumbrella tentacles.

In young medusæ about 15 mm. wide there are about 70 exumbrella tentacles, but in a specimen 75 mm. in diameter there were 264. The exumbrella tentacles may project outward from the bell at any level from very near the apex to a short distance above the margin; their entodermal cores traverse the jelly and are connected with the ring-canal. The majority of the exumbrella tentacles arise from a zone at a very short distance above the margin, but others arise at various higher levels from the sides of the bell, and the roots of these latter tentacles are correspondingly long and are accompanied by streaks of thickened peronial cells loaded with ivory-black pigment-granules. In young medusæ very few of the exumbrella tentacles arise from these higher levels, but as the medusa grows, more and more of them migrate upward. The pigmented streaks marking the path of migration of the tentacles are ectodermal peronia and are continuous with the nettle-ring of the bell-margin.

The exumbrella tentacles are somewhat shorter than the bell-radius and are club-shaped, expanding outwardly. There are numerous elongated nettling warts set transversely across the tentacles, and the outer ends of the tentacles are slightly curled inward and provided with a thick, elliptical pad of mucous gland-cells, which serves as a "sucker" to attach the animal. This pad may be on the oral, aboral, or terminal part of the outer end of the tentacle.

There are about 300 marginal bulbs, loaded with immature nematocysts, and about 10 to 15 highly-contractile, marginal tentacles. These are provided with many partial rings of nematocysts, the openings of the rings being on the inner (oral) side, and extending along this open space there is a thick strand of striated muscle fibers. These velar, or marginal, tentacles

are constantly contracting into helical coils and then expanding, and it is apparently their office to capture prey. These contractile tentacles grow out from the marginal bulbs: and indeed, the marginal bulbs are only embryonic or rudimentary velar tentacles.

There are 2 lithocysts at the base of the entodermal core of each exumbrella tentacle. Each lithocyst is a closed vesicle, buried in the gelatinous substance on the outer side of the ring-canal at a short distance above the bell-margin. Each lithocyst contains a single, refractive, spherical concretion, which is suspended in the cavity of the vesicle and is supported by and contained within a club-like mass of cells. The lithocyst and concretion are according to Goto of *ectodermal* origin, but this may seem improbable in view of their known *entodermal* origin in the closely allied genus *Gonionemus*.

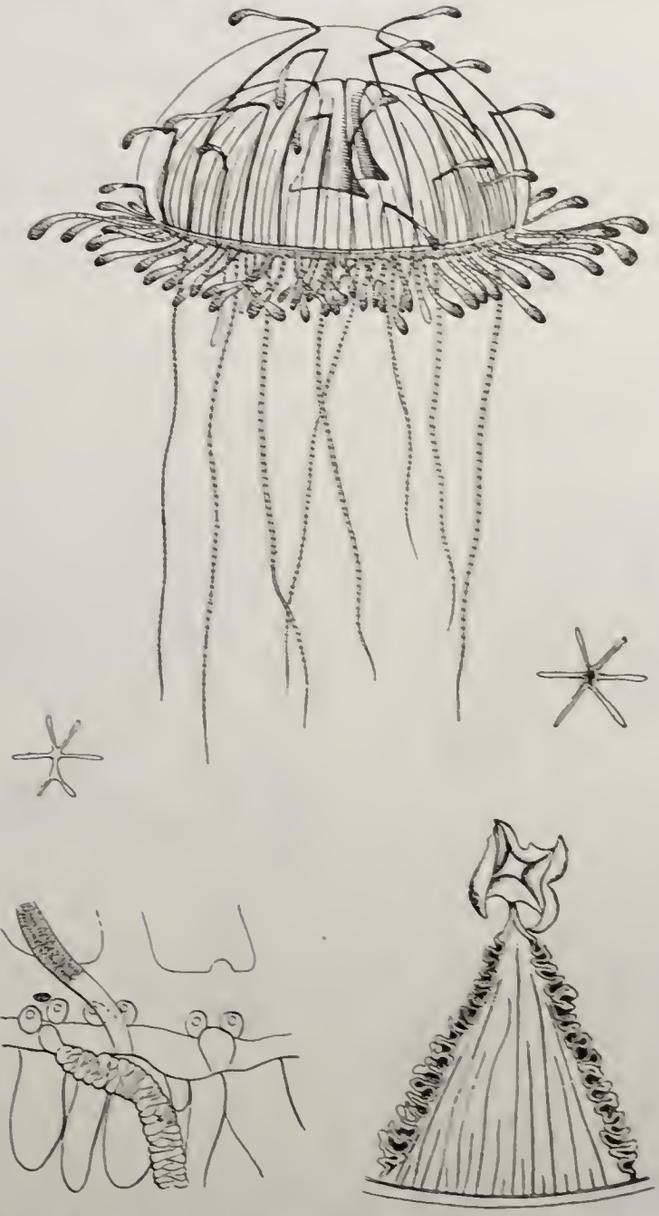


Fig. 203.—*Olindioides formosa*, after Goto, in Mark Anniversary Volume. Showing sector of bell, part of bell-margin, and two views showing mode of origin of 6 radial-canals from manubrium.

The manubrium is 4-sided, prismatic, with 4 simple, somewhat flaring lips. 4 canals arise from the 4 corners of the stomach, but 2 of these primary canals bifurcate immediately after leaving the stomach so that there are 6 radial-canals which reach the circular vessel 60° apart. The ring-canal is broad and gives rise to numerous blindly ending, centripetal

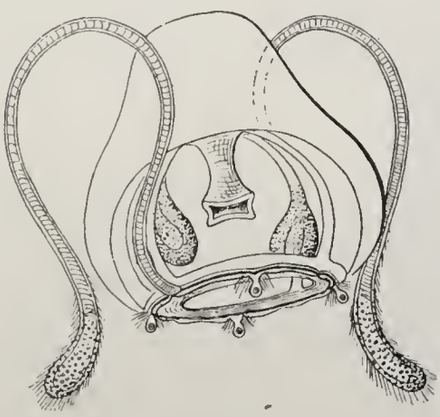
canals, which increase with age. In young medusæ 15 mm. in diameter, the centripetal vessels ranged from 11 to 14 per sextant, about 78 in all; whereas in a mature medusa 75 mm. wide the centripetal canals varied from 18 to 23 in the several sextants, or about 120 all told.

The 6 gonads are foldings of the subumbrella walls of the 6 radial-canals and extend throughout the greater portion of their lengths, leaving only a short proximal, and a much shorter distal, extremity of the canal free. The young gonads are sinuously folded from side to side of each canal, but later they give rise to numerous lobes, which may become secondarily lobed, as in *Olindias*.

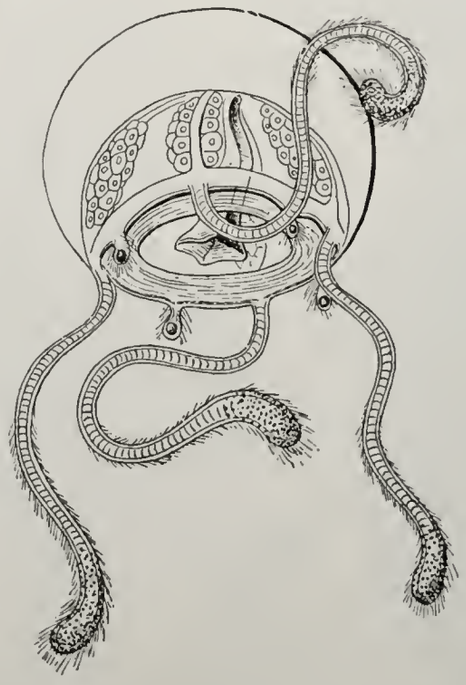
The tips of the exumbrella tentacles are transparent lilac; their middle and proximal lengths are smaragdine-green. The peronial strands and basal parts of those tentacles which project from the exumbrella at a high level are ivory-black. The radial and circular canals are deep scarlet and the centripetal vessels are of a lighter hue of the same color. There is a small, green, triangular spot at each of the 4 corners of the base of the manubrium, on either side of which there is a lilac area, and there are one or two somewhat irregular longitudinal lilac streaks along the middle of each side of the manubrium. The tips of some of the filiform tentacles are tinged with green and lilac. The gonads are egg-yellow.

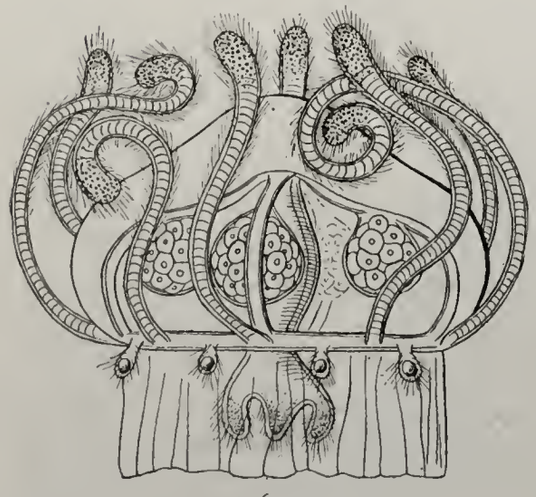
The medusa is found from December to June or July at Misaki and at other places in the Bay of Tokyo, Japan. It is a bottom form and appears to be most abundant in water 20 to 30 fathoms deep. It is beautifully figured by Goto, who gives also a very detailed and clear description of the medusa.

204.



205.





206.

FIG. 204.—"*Dipetasus digonimus*," after Haeckel.
FIG. 205.—"*Petasus atavus*," after Haeckel, in Syst. der Medusen.
FIG. 206.—"*Petasata eucope*," after Haeckel, in Syst. der Medusen.

Subfamily PETASINÆ Haeckel, 1879 (in part).

Petasidæ (in part), Haeckel, 1879, Syst. der Medusen, p. 247.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 735.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 45; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 488, Jena.

SUBFAMILY CHARACTERS.

Trachymedusæ with 4 radial-canals upon which the swollen, linear, or sac-like gonads are developed. Tentacles without adhesive disks.

This subfamily is separated from the Geryonidæ by its sac-like protrusive gonads, whereas the gonads of the Geryonidæ are leaf-like expansions. It is distinguished from the very closely allied Olindiadæ by its simple tentacles, whereas the tentacles in the Olindiadæ bear adhesive pads. A synopsis of the genera of the Petasinæ follows:

Petasus Haeckel *sens. emend.*=*Petasus*+*Dipetasus*+*Petatasata*+*Petachnum* Haeckel, 1879. Tentacles arising at equal intervals, not grouped in clusters. Free marginal lithocyst-clubs. 4 radial-canals. No centripetal canals. Development unknown.

Aglauropsis F. Müller, 1865. Similar to *Petasus*, but with inclosed vesicular lithocysts.

Craspedacusta Lankester, 1880=*Limnocodium* Allman, 1880. This may be identical with *Aglauropsis*, but has elongate cavities in which the sensory-clubs are contained.

(?) *Microhydra* Potts, 1885, may be identical with *Craspedacusta*, but the mature medusa is unknown.

Gossea L. Agassiz, 1862. No centripetal canals. The tentacles are grouped into clusters and do not arise at equal intervals from the bell-margin.

Marotias Ostroumoff, 1896. With 4 radial-canals and numerous blindly ending, centripetal canals. Tentacles arise at equal intervals from the bell-margin. Development unknown.

Tabular Synopsis of Petasus and Allied Genera, according to Haeckel.

	Petasus atavus Haeckel, 1879, p. 248, taf. 18, fig. 1.	Petasus tetranema Haeckel, 1879, p. 248.	Dipetasus digonimus Haeckel. 1879, p. 249, taf. 18, fig. 2.	Petasata eucope Haeckel, 1879, p. 249, taf. 18, fig. 3.	Petasata rabbeana Haeckel, 1879, p. 637.	Petachnum tiaropsis Haeckel, 1879, p. 250.
Size of bell in mm.	1 high, 1 wide. Globular.	0.7 high, 0.8 wide.	1 high, 1 wide. Pyriform.	1 high, 2 wide. Sides flaring, pyriform.	5 high, 10 wide. Hemispherical.	3 high, 10 wide. Flat.
Number and character of tentacles.	4, longer than bell-diameter, with club-shaped, ciliated outer ends.	4, similar to P. atavus, but shorter than bell-diameter.	2, longer than bell-diameter, with club-shaped, ciliated outer ends.	8, not quite as long as bell-diameter. Ends club-shaped and ciliated.	8, solid with club-shaped ends. The 4 interradial as long as bell-diameter; and the 4 radial over twice this length.	100+, hardly as long as bell-radius. Cylindrical with thick tips.
Number of marginal sensory-clubs.	4	4	4	8	8	8
Character of stomach.	Prismatic, mouth with 4 short lips, at level of velar opening.	Short, cylindrical. Mouth 4-sided.	Short, 4-sided, prismatic.	Cylindrical, as long as bell-height. With 4 short, curved, ciliated lips.	Cylindrical, twice as long as bell-height. Mouth with 4 lancet-shaped, pointed lips.	Short, hardly as long as bell-height, 4 lips.
Character of gonads.	Spindle-shaped on middle two-thirds of radial-canals.	Band-shaped, bilamellar, developed over entire lengths of radial-canals.	2 club-shaped in middle of 2 of radial-canals.	4 spherical sacs in middle of 4 radial-canals.	(8?) spindle-shaped sacs upon distal halves of radial-canals. 4 gonads (?)	Club-shaped, two-thirds as long as radial-canals. Touching margin.
Color.	Stomach and tentacles red, darkly speckled at ends.	Light-yellow. Tentacle-tips red.	?	Stomach rose-red. Gonads yellowish. Bell-margin purple-red.	?	?
Where found.	Gulf of Smyrna, April.	Canary Islands, February.	Kerguelen Islands, Antarctic Ocean. (*Challenger* Expedition).	Red Sea. Arabian coast between Tur and Suez. This is probably young of *P. rabbeana*.	Indian Ocean, south of Madagascar. Probably mature form of *P.* "*eucope*." Haeckel states that there are 8 gonads. This is probably a misprint.	China Sea.

Genus PETASUS Haeckel, 1879, sens. ampl.

Petasus+Dipetasus+Petasata+Petachnum, Haeckel, 1879, Syst. der Medusen, pp. 247, 248, 249, 250.

GENERIC CHARACTERS.

Petasidæ with free, marginal sensory-clubs and with tentacles arising at equal intervals; not grouped in clusters. 4 sac-like gonads on the 4 radial-canals. 4 lips. No peduncle. No centripetal vessels. Tentacles without adhesive disks.

Haeckel describes a number of small and apparently immature medusæ under the genera *Petasus*, *Dipetasus*, *Petasata*, and *Petachnum*. He is the only naturalist who has seen any of these medusæ. Their generic characters, as given by Haeckel, may be summarized as follows: *Petasus*, with 4 free, interradial sensory-clubs and 4 tentacles; *Dipetasus*, with 4 free, interradial sensory-clubs and 2 tentacles; *Petasata*, with 8 free, adradial sensory-clubs and 8 tentacles; *Petachnum*, with 8 free, adradial sensory-clubs and 12 or more tentacles.

These genera appear to me to be too narrowly circumscribed to be of service in a general classification. For example, no allowance is made for the possible discovery of medusæ with 8 lithocysts and 4 tentacles or with more than 8 lithocysts and any number of tentacles. Moreover, when we study Haeckel's descriptions of these medusæ we see a gradual increase in size from those called *Petasus* to those designated *Petasata* and *Petachnum*. It is well known that gonads often begin to develop upon the radial-canals of Trachymedusæ at very early stages, and one may readily be deceived into forming the opinion that such growth-stages are mature, Haeckel distinguishes these forms as shown on page 361.

Genus AGLAUROPSIS F. Müller, 1865.

Aglauropsis, Müller, 1865, Archiv. für Mikroscop. Anatomie, Bd. 1, p. 144.—Haeckel, 1879, Syst. der Medusen, p. 250.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 736.

The type species is *Aglauropsis agassizii* F. Müller, from the coast of Brazil.

GENERIC CHARACTERS.

Petasidæ with small vesicular lithocysts upon the bell-margin between the tentacles. Without free marginal lithocyst-clubs. Tentacles arise at equal intervals and are not grouped in clusters. 4 gonads on the 4 radial-canals. 4 lips. No peduncle. No centripetal canals. Tentacles without adhesive disks.

This genus is closely related to *Petasus*, but it is distinguished by its inclosed vesicular lithocyst-capsules and by the absence of free sensory-clubs upon the bell-margin. It is distinguished from *Mœotias* by the absence of blindly ending centripetal canals.

The species are very imperfectly known, Müller's description of the Brazilian and Browne's account of the Falkland Island medusæ being incomplete.

Aglauropsis agassizii Müller.

Aglauropsis agassizii, Müller, 1865, Archiv. für Mikroscop. Anatomie, Bd. 1, p. 144, taf. 7, fig. 4.—Haeckel, 1879, Syst. der Medusen, p. 250.

Müller's description of this medusa is so meager that even generic characters are not properly described. We only know that the medusa is found on the coast of Brazil and that it has 4 gonads on the 4 radial-canals and a large number of vesicular lithocysts and tentacles. The medusa may be identical with Browne's *Aglauropsis conantii*. I can not separate this medusa from *Craspedacusta*, yet our knowledge of it is so inadequate that I may not venture to unite the genera.

Aglauropsis conantii Browne.

Aglauropsis conantii, Browne, 1902, Annals and Mag. Nat. Hist., ser. 7, vol. 9, p. 283; 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, p. 151.

Umbrella bowl-shaped, with an everted margin, a little broader than high; 18 mm. high and 20 mm. wide. About 200 or more marginal tentacles closely packed in two or three alternating rows around the margin. About 50 or more internal lithocysts adjoining the ring-

canal. Each lithocyst contains a single (ectodermal?) concretion. Radial-canals and ring-canal very broad. Stomach somewhat cone-shaped and about half the length of bell-cavity. Mouth with 4 large, perradial lips with a folded margin. The gonads are transversely divided lobes and occupy nearly the whole length of the radial-canals, but are separated by short spaces, both from stomach and ring-canal. Common at Stanley Harbor, Falkland Islands.

Genus CRASPEDACUSTA Lankester, 1880.

Craspedacusta, Lankester, 1880, Nature, vol. 22, p. 147.

Limnocodium, Allman, 1880, Nature, vol. 22, p. 178; Journ. Linnean Soc. London, vol. 15, p. 131.—Günther, 1894, Quart. Journ. Micros. Sci., vol. 5, p. 539 (finds tentacles hollow).—Goto, 1905, Mark Anniversary Volume, pp. 17, 18.—Potts, 1906, Quart. Journ. Microscop. Sci., vol. 50, p. 623.—Browne, 1906, Quart. Journ. Microscop. Sci., vol. 50, p. 638.—Oka, 1908, Annot. Zoolog. Japonenses, vol. 6, p. 225.

Limnocodium (Craspedacustes), Lankester, 1880, Quart. Journ. Microscop. Sci., vol. 20, p. 351.

The type species is *Craspedacusta sowerbii* Lankester, first described by Lankester, later by Allman, from the fresh-waterlily tank containing *Victoria regia* in Regent's Park, London. The genus appears to be separated from *Aglauropsis* only by the elongate cavities in its velum which contain the sensory-clubs, having concretions of entodermal origin.

GENERIC CHARACTERS.

Trachymedusæ of the family *Petasidæ*. Numerous hollow tentacles projecting at various levels from the sides of the bell above the margin. The entodermal cores of the tentacles are continuous with the entoderm of the ring-canal. Numerous entodermal lithocyst-clubs inclosed in closed elongate cavities within the gelatinous substance of the velum. The lithocyst chambers are lined with ectoderm, which also incases the entodermal cores of the sensory-clubs. 4 radial-canals and a ring-canal. No centripetal canals. 4 gonads on the 4 radial-canals. Manubrium tubular, with 4 lips. The hydroid attributed to this species is devoid of tentacles and with a terminal mouth. Medusa-bud produced at the oral extremity of the polypite.

The generic name *Craspedacusta* was first proposed by Lankester in his published account of the medusa in Nature, vol. 22, p. 147, on June 17, 1880. On the same day Professor Allman read a paper upon the medusa before the Linnean Society of London in which he proposed the generic name "*Limnocodium*." He did not publish this name, however, until June 24, 1880, when it appears in his paper in Nature, vol. 22, p. 178. If it be true that generic names must date from the time of printed publication, the name *Craspedacusta* clearly has precedence over that of *Limnocodium*. The medusa has, however, been commonly known to literature under the name *Limnocodium sowerbii*, the generic designation being derived from Allman and the specific name from Lankester. This evidently violates the accepted rules of nomenclature.

Regretting, however, to revive an unfamiliar name to supplant one very familiar to all students of the medusæ, I applied, on August 28, 1907, to the International Commission on Zoological Nomenclature for permission to retain the well-known name *Limnocodium*. This petition was answered in the negative as follows:

[Opinion Rendered by the International Commission on Zoological Nomenclature.]

Summary.—*Craspedacusta sowerbii* Lankester, 1880, June 17, has clear priority over *Limnocodium victoria* Allman, 1880, June 24. Presentation of a paper before a scientific society does not constitute publication in the sense of the Code. Publication defined. The Commission is without authority to sanction usage in contravention to the provisions of the Code.

Craspedacusta sowerbii Lankester.

Craspedacusta sowerbii, Lankester, 1880, Nature, vol. 22, pp. 147, 177, 190, 241.

Limnocodium victoria, Allman, 1880, Nature, vol. 22, pp. 178, 218, 290.

Limnocodium sowerbii, Romanes, 1880, Nature, vol. 22, p. 179; 1881, Quart. Journ. Micr. Sci., vol. 21, p. 162 (physiology).—Lankester, 1893, Nature, London, vol. 49, p. 127 (appearance of the medusa in the *Victoria regia* tank at Sheffield, England).—Günther, 1894, Quart. Journ. Microscop. Sci., vol. 35, p. 539, plate 40 (histology).—Vanet & Conte, 1901, Zool. Anzeiger, Bd. 24, 533, 1 fig. (found at Lyons, France, in a waterlily pond; figs. of spermatozoon).—Potts, 1906, Quart. Journ. Micr. Sci., vol. 50, p. 623, plate 35, figs. 1–11 (reproductions of previous figures of hydroid and medusa).—Browne, 1906, Quart. Journ. Micr. Sci., vol. 50, p. 638, plate 37, figs. 3, 3.—Maas, 1907, Zeit. für Allgemeine Physiol., Bd. 17, p. 1.—Hargitt, 1908, Biolog. Bulletin, vol. 14, p. 304, figs. 1–7 (found at Washington, D. C.).

Limnocodium (*Craspedacustes*) *sowerbii*, Lankester, 1880, Quart. Journ. Microscop. Sci., vol. 20, p. 351, figs.; 1881, *Ibid.*, vol. 21, p. 119, plates 8–10.

Limnocodium victoria (*sowerbii*), Allman, 1880, Journ. Linnean Soc. London, vol. 15, p. 131, figs.
Limnocodium sowerbii (hydroid), Bourne, 1884, Proc. Roy. Soc. London, vol. 38, p. 9.
Limnocodium, *sp.*, Romanes, 1885, Jelly-fish, Star-fish, and Sea-urchins, p. 242, fig. 31.
Limnocodium sowerbyi, Fowler, 1890, Quart. Jour. Micros. Sci. London, vol. 30, p. 507, plate 33 (hydroid, development of medusa, and references to previous literature).
Limnocodium, *sp.*, Lankester, Minchin, Fowler, and Bourne, 1900, Treatise on Zool., Part 2, Hydromedusæ, p. 47.
Limnocodium——, Boecker, 1905, Biol. Centralbl., Bd. 25, p. 605 (found at München, Bavaria).—Cremer, 1907, Sitsungsber. Gesell. Morph. Phys., München, Bd. 22, p. 41.

This interesting medusa was first found by Mr. Sowerby during 1880 in the fresh-water tank devoted to the cultivation of the large waterlily, *Victoria regia*, in Regent's Park, London. The temperature of the water was 86° to 90° F. It has since then been introduced into other waterlily tanks in England, France, Germany, and the United States. It feeds upon *Daphnia*, and was probably introduced from South America or the West Indies. Mr. Sowerby presented specimens of the medusa to Allman and Lankester, who described them.

Adult medusa.—Bell nearly hemispherical, about 12 mm. wide. Gelatinous substance quite thin. Nearly 200 marginal tentacles, of various sizes, the oldest being the largest; these tentacles project at various levels from the sides of bell, slightly above margin. The 4 largest (perradial) tentacles project from the sides of the bell at some distance above the margin. Projecting from a zone lower down, nearer the margin, are about 28 or more tentacles of medium sizes, and lowest of all is a third set of about 192 or more small tentacles. The entodermal cores of these tentacles are hollow and their ectoderm bears prominent nematocyst-warts at fairly regular intervals. The largest tentacles are usually somewhat longer than bell-diameter, but all are highly contractile. They taper gradually from base to tip and lack suckers or other appendages. No ocelli.

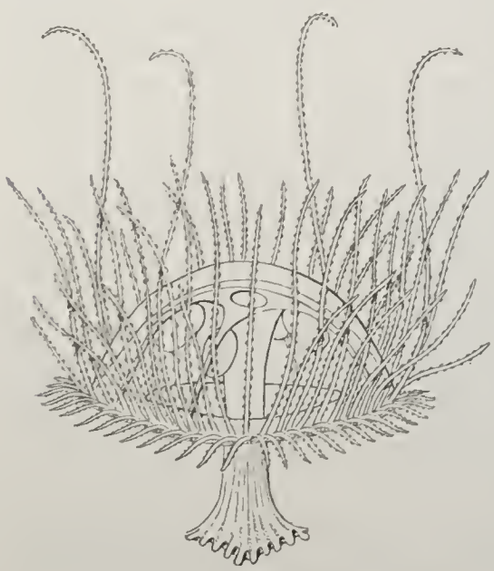


Fig. 207.—*Craspedacusta sowerbii*, after Allman.

There are about 128 lithocyst-organs scattered somewhat irregularly between the tentacles. Each of these organs is composed of an ovoid cluster of entodermal cells on the inner (velar) side of the ring-canal. This ovoid "otolith" is suspended by means of a short, narrow stalk and is contained in an elongate, pyriform, closed capsule within the gelatinous substance of the velum. This capsule is lined with thin, ectodermal epithelium which also incases the ball-like mass of entodermal cells constituting the "otolith." Velum is thick and gelatinous; the large, elongate, closed lithocyst cavities project centripetally into its gelatinous substance. 4 narrow, straight radial-canals and a marginal ring-canal without centripetal diverticula. This ring-canal is quite wide and pursues a sinuous course around the margin, rising highest at the points of origin of the largest tentacles. The manubrium is prismatic below, tubular above, and projects for about half its length beyond velar opening. 4 large lips with folded, crenated edges. 4 sac-shaped gonads arise from the 4 radial-canals, somewhat nearer to radial corners of stomach than to bell-margin. Only male medusæ have been observed.

Entoderm of manubrium, gonads, and bell-margin brownish-yellow, other parts colorless.

Hydroid.—That which is probably the hydroid of this medusa was first found by Parsons, 1880, and first described by Bourne, 1884. It grows in colonies of 2 or 3 polypites arising from common base and is attached to the under sides of leaves, etc., floating or growing in the water of the lily-tank in Regent's Park. The polypites are only about 0.6 mm. long and are cylindrical with rounded peristomes devoid of tentacles. The mouth is a simple terminal opening. There is no perisarc, but the sides and bases of the polypites are incased in a coating of sticks, detritus, etc., caught apparently in slime. The oral ends are, however, free from this detritus. Planula-shaped buds are produced upon the basal halves of the sides of the polypites, and these are set free and settle down to form new colonies of hydroids, very much as in *Microhydra ryderi*. The medusa-bud is produced at the oral end of the polypite, both

ectoderm and entoderm taking part in its formation. Thus each polypite *appears* to give rise to but one medusa, although the detachment of the medusa and future fate of the polypite has not been observed. We must bear in mind that it is not yet certain that this hydroid is actually the asexual generation of *C. sowerbii*.

The young stages in the development of the free medusa, found in the lily-tank, have been studied by Lankester, 1881 (Quart. Journ. Microscop. Soc. London, vol. 21, p. 194, 5 figs.). When the embryo is less than 1 mm. in diameter the body is globular with 8 very small tentacles, 4 radial, 4 interradial, and 2 marginal lithocysts. The velum is present as a diaphragm-like membrane at the bases of the tentacles; but inside of, and separate from, the velum there is said to be a peculiar imperforate membrane which completely closes the bell-cavity. The manubrium is well developed at this stage and there are 4 radial-canals.

Haeckel (Jena. Zeitschift, Bd. 2) states that the subumbrella cavity in *Geryonia* forms as a closed sac, and only later does the membrane closing it break through. This observation is in accord with Lankester's studies on *Craspedacusta*, but is opposed to the observations of Metschnikoff, Brooks, and others on Geryonidæ.

Romanes, 1880, 1881, found that the medusa is exceedingly intolerant of ocean water and is injuriously affected by fresh water which is diluted with one-ninth of its volume of ocean water. The medusa is strongly positive in its heliotropism, and during the day it is found in the highest and most brightly lighted part of the tank, but it sinks to the bottom at night.

In 1881 Lankester found that the entodermal cells near the mouth are gland-cells and produce a secretion. The cells of the mid-region of the stomach are inactive, but those of the inner region of the stomach, near the place of origin of the radial-canals, send out *amœboid* processes and engulf solid food particles into their protoplasm. A similar process of intracellular digestion has been demonstrated by Metschnikoff and by Jeffery Parker in hydroids, and in their medusæ.

Maas, 1907, finds that the medusa will pulsate spontaneously if even a small portion of the bell-margin be left intact. With margin completely removed no spontaneous pulsations occur, but the central disk may still respond temporarily to stimuli such as NaCl, KCl, mechanical shock, or electric current. The manubrium bends toward the cathode. Hargitt, 1908, finds that the normal medusa can not continue to pulsate if placed in distilled water, but he does not determine whether this inhibition is due to lack of sodium, etc., or to the deficiency of oxygen.

Cremer, 1907, made a study of the phenomena of rhythmical pulsation in *Craspedacusta*, using a galvanometer. He finds that the electromotive force of the epithelial muscular system of this medusa is nearly as great as in the muscles of warm-blooded animals. This seems the more remarkable in view of the relative deficiency of salts in the fresh water surrounding the medusa. Cremer points out a possible analogy between the action of the muscles of this medusa in maintaining pulsation and the electric organs of electrical fishes in giving shocks.

Craspedacusta kawaii.

Limnocodium kawaii, Oka, 1907, Annotationes Zoologicæ Japonenses, vol. 6, part 3, p. 219, taf. 8, 3 fign.: 1907, Zoolog. Anzeiger, Bd. 32, p. 669.

This medusa is from the fresh water of the Yang-tse-kiang River, in China, 1,000 nautical miles from the river's mouth, near I-tschang. 10 examples were captured in April and are described from preserved material by Oka.

It is closely allied to *C. sowerbii*. Bell 20 mm. wide, hemispherical. Velum one-fourth as wide as bell-opening. More than 256 tentacles in 7 different orders of size. The tentacles project from the sides of the bell above the margin, the largest (perradial) tentacles being the highest up. 4 elongate, oral, leaf-shaped gonads which arise from the radial-canals near the stomach and project downward to the level of the velar opening. The lithocysts are similar to those of *C. sowerbii*.

C. kawaii differs from *C. sowerbii* in its rounded bell, larger size, and in having 7 sets of tentacles instead of 3 as in *C. sowerbii*. The hemispherical form of its bell may, however, be due to contraction, and it may be an exceptionally flourishing variety of *C. sowerbii*, exhibiting a further growth of tentacles and attaining a larger size. This is rendered the

more probable from the fact that *C. sowerbii* has hitherto been seen only in relatively small artificial waterlily tanks, and its native habitat remains unknown. It may therefore fail to develop as fully in these restricted, artificial surroundings as in a state of nature. The medusa may have been introduced into the Yang-tse-kiang through the well-known religious interest of the Chinese in the cultivation of waterlilies.

Genus MICROHYDRA Potts, 1885.

Microhydra, Potts, 1885, Science, vol. 5, No. 125, cover sheets, p. v; 1897, American Naturalist, vol. 31, p. 1032.
Pottsia, Ryder, 1885, Science, vol. 5, p. 1236.

The type species is *Microhydra ryderi*, of a fresh-water stream called Tacony Creek, near Philadelphia.

Potts established this genus for a small medusa with 8 tentacles, 4 radial-canals, 4 lips, and neither lithocysts nor ocelli. It is set free from a minute clavate hydroid which lacks tentacles and grows singly or in small clusters upon stones in the bottom of the creek. The medusa-bud is developed upon the side of the hydroid and arises singly, being mounted upon a well-developed pedicel. The hydroid also reproduces asexually. The mature medusa is unknown and it is, therefore, impossible to define any generic characters.

Microhydra ryderi Potts.

Microhydra ryderi, Potts, 1885, Science, vol. 5, No. 123, cover sheets, p. v. (hydroid); 1897, American Naturalist, vol. 31, p. 1032, Annals and Mag. Nat. Hist., ser. 7, vol. 1, p. 130 (medusa and hydroid); 1908, Proc. Delaware County Institute of Sci., vol. 3, p. 89, plates 1–4; 1906, Quart. Journal Microscop. Sci., vol. 50, p. 623, plate 36, figs. 13–26 (hydroid and medusa).—Browne, 1906, Quart. Journal Microscop. Sci., vol. 50, p. 635, plate 37, figs. 1, 2, 4 (medusa).—Ryder, 1885, Amer. Naturalist, vol. 19, p. 1232.
Pottsia ryderi, Ryder, 1885, *Ibid.*, p. 1236 (medusa).

Just after separation from the hydroid the medusa is about 0.4 mm. in diameter. Bell thin-walled, dome-shaped, 0.3 mm. high. 8 equally developed tentacles, about half as long as bell-diameter. No marginal lithocysts. Velum wide, its aperture only one-third to one-fourth of diameter of bell. Manubrium simple, conical at base, and four-cornered below, about one-half to two-thirds as long as bell-height. 4 straight, slender radial-canals, no gonads.

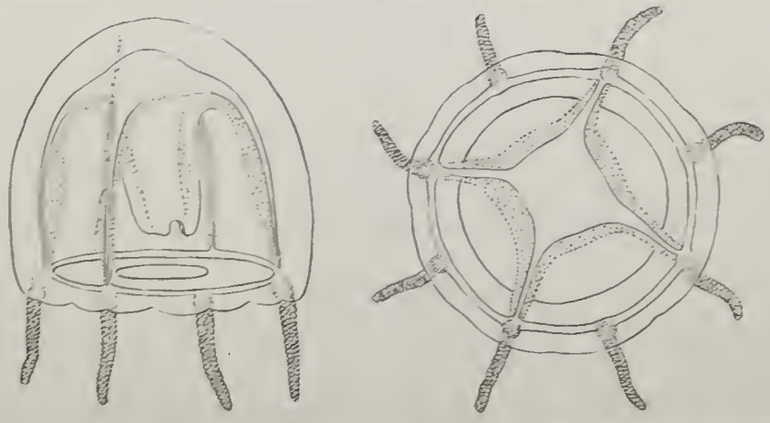


Fig. 208.—*Microhydra ryderi*, from camera-lucida drawings by Prof. J. Percy Moore, kindly lent to author by Mr. Edward Potts. The medusæ were drawn from specimens 48 to 50 hours old.

These medusæ bud off singly from the side of a small hydroid which is devoid of tentacles and lives in the rocky bed of Tacony Creek, a rapidly flowing, fresh-water tributary of the Delaware River, near Philadelphia, Pennsylvania. Potts believes that this form may eventually prove identical with *Craspedacusta sowerbii* of the Regents Park, London.

The hydroid is clavate, almost cylindrical, with a rounded, upper mouth-end, devoid of tentacles. It usually grows singly, although occasionally two are seen connected at their common base. The hydroid gives rise to sausage-shaped buds which arise from the side of the parent hydroid. These buds develop in such a manner that the final separation of the bud occurs at one side instead of being terminal, as in *Craspedacusta*. When set free the bud falls to the bottom and moves about to some slight extent by amœboid or vermiform con-

tractions. It is devoid of cilia. Finally one end becomes attached and the other is elevated into an erect position. When fully grown this minute hydroid is only 0.5 mm. high and from 0.15 to 0.175 mm. in diameter. The hydroid devours rotifers, which it captures by means of its nematocysts. Browne, 1906, finds that Allman's hydroid, *Schizocladium ramosum* (= *Obelia*) gives off fission frustules, the structure of which exactly resembles those of *Microhydra ryderi*.

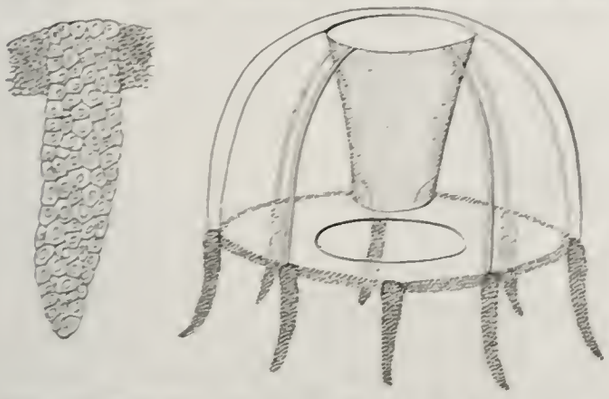


FIG. 209.—*Microhydra ryderi*, after Browne, in Quarterly Journ. Microscop. Sci. Showing enlarged view of one of the tentacles.

It is possible that the medusa of *Microhydra* may prove to be closely related to *Craspedacusta sowerbii* of the lily-tank in Regents Park, London. It differs considerably, however, in its young stage from the young of *Craspedacusta*, for the young *Microhydra* medusa lacks all trace of lithocysts while the *Craspedacusta* has at least one lithocyst when set free, but is in other respects far less advanced than the *Microhydra* medusa. Moreover, the nematocyst clusters upon the tentacles of *Craspedacusta* are mounted upon prominent papillæ, whereas those of *Microhydra* are flat (see Browne, 1906, plate 37, figs. 2, 3). Potts, 1908, gives a detailed account of the feeding habits of the hydroid and the formation of the medusa-bud.

Genus GOSSEA L. Agassiz, 1862.

Gossea, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 366.—HAECKEL, 1879, Syst. der Medusen, p. 251.—BROWNE, 1902, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 736.—BIGELOW, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 103.

The type species is *Gossea corynetes* described from the coast of Devonshire, England, as *Thaumantias corynetes* by Gosse, 1853. Haeckel describes a later stage of the same medusa under the name "*Gossea circinata*."

GENERIC CHARACTERS.

Petasidæ in which the tentacles are grouped into clusters and do not arise at equal intervals from the sides of the bell. No centripetal canals. Development unknown. Bigelow finds that the tentacles are solid, not hollow as described by Haeckel.

Gossea corynetes L. Agassiz.

Thaumantias corynetes, GOSSE, 1853, Naturalist's Rambles Devonshire Coast, p. 407, plate 21.
Gossea corynetes, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 366.
Gossea circinata, HAECKEL, 1879, Syst. der Medusen, p. 252, taf. 18, fig. 4.—DELAP, M. AND C., 1905, Annual Report Fisheries of Ireland, 1902–03, part 2, appendix 4, p. 14.

Haeckel describes a medusa under the name *Gossea circinata* from the Atlantic coast of France, which is probably the fully developed stage of *Gossea corynetes* (*Thaumantias corynetes*) Gosse, from the coast of Devonshire, England.

Haeckel's medusa has the following characters: Bell somewhat fuller than a hemisphere, evenly rounded, with fairly thick gelatinous substance at the center, but thin at the margin. 12 mm. wide, 10 mm. high. There are 24 large, club-shaped tentacles arranged in 8 (4 radial, 4 interradial) groups of 3 tentacles each. These are not quite as long as the bell-diameter, are armed with numerous swollen rings of nematocysts. Each tentacle projects inward in a spur-like basal extension into the gelatinous substance of bell above margin. About 8 short, adradial, slender, helically-coiled marginal cirri, which alternate in position with the 8 clusters of tentacles. 24 inclosed lithocysts, 3 between each cluster of tentacles. These lithocysts lie above the ring-canal on the inner side of the velum, and each capsule contains a single spherical concretion. Velum wide and muscular. Ring-canal simple. 4 straight, simple radial-canals. Stomach 4-sided, urn-shaped to conical, with 4 recurved lips with

folded edges, about half as long as depth of bell-cavity. The 4 swollen spindle-shaped to club-shaped gonads are upon the middle three-fourths of the radial-canals. Stomach green, mouth rose-red, gonads yellowish, tentacles rusty-yellow or leather-yellow each with a brownish-red basal ocellus. Found on the coast of France, Bretagne, at Croisic near St. Nazaire, in September. The Misses Delap found it at Valencia Harbor, Ireland.

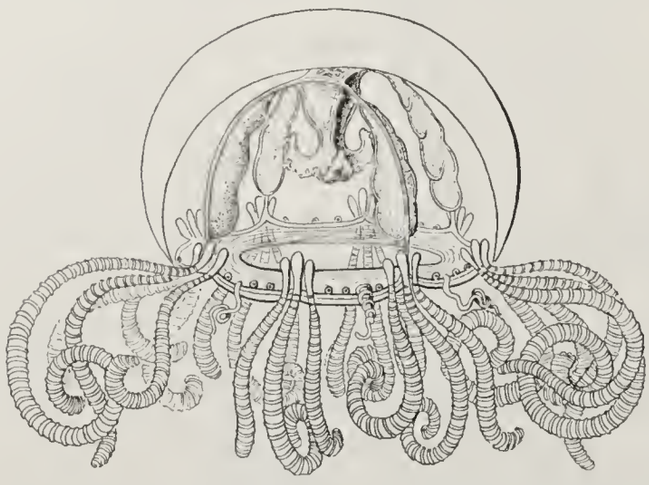


FIG. 210.—*Gossea "circinata,"* after Haeckel, in Syst. der Medusen=*Gossea corynetes.*

Thaumantias corynetes Gosse, from the coast of Devonshire, England, appears to be a young stage of the medusa described by Haeckel as "*Gossea circinata*"; as will appear from the following analysis of their characters:

	Size of bell in mm.	No. of tentacles.	Form of lips.	Position of gonads.
"Thaumantias" corynetes Gosse.	6 wide, 8 high.	16, 2 in each radial and interradial cluster.	Simple, small.	Confined to outer halves of radial-canals.
Gossea circinata Haeckel.	12 wide, 10 high.	24, 3 in each cluster.	Well developed.	On middle three-fourths of radial-canals.

In other respects the two "species" are identical.

Gossea brachymera Bigelow.

Gossea brachymera, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 103, plate 30, figs. 1-10.

Bell 5 mm. wide and 4 mm. high, dome-shaped with thick gelatinous walls and very shallow bell-cavity. 8 groups of tentacles, 4 radial and 4 interradial, 8 simple adradial tentacles, and 16 marginal papillæ. Each radial and interradial cluster contains only 2 tentacles, one of which is about as long as the bell-diameter and is ringed with nettle-cells and terminates in a knob of nematocysts. These long tentacles project from the exumbrella at a short distance above the margin. The other tentacle of each cluster is very short, but has nettle-rings and a terminal knob. It arises from the basal bulb at the bell-margin, below the long tentacle with which it is associated. The tentacles are all solid with chordate entoderm. Bigelow can give no certain account of the lithocysts. The stomach is mounted upon a short, broad peduncle, and this peculiarity serves to distinguish this species. There are 4 triangular slightly fimbriated lips. 4 simple, folded gonads on middle thirds of the radial-canals. Color in life (?) In formalin gonads, tentacles, and manubrium are pale yellowish-brown. Acapulco Harbor, Pacific coast of Mexico. A single specimen.

Genus MÆOTIAS Ostrooumoff, 1896.

Mæotias, OSTROOUMOFF, 1896, Bull. Acad. Impériale Sci. St. Pétersbourg, sér. 5, tome 4, No. 4, p. 402; Zool. Anzeiger, Bd. 19, p. 30.—BROWNE, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, part 3, p. 736.

The type species is *Mæotias inexspectata* Ostrooumoff, from the Sea of Azov, Russia.

GENERIC CHARACTERS.

Petasidæ with 4 radial-canals and with blindly ending centripetal canals which arise from the ring-canal. Numerous tentacles which arise at equal intervals from the bell-margin. 4 lips, 4 radial-canals, 4 gonads. Development unknown.

Ostrooumoff states that this genus resembles *Olindias*, but that the tentacles are all of one sort, the stiff, laterally projecting tentacles being absent. His description and figure fail to demonstrate the presence of adhesive disks on the tentacles, and I am inclined, with Browne, to consider this genus to be more nearly allied to *Aglauropsis* than to *Olindias*.

Mæotias inexspectata Ostrooumoff.

Mæotias inexspectata, Ostrooumoff, 1896, Zool. Anzeiger, Bd. 19, p. 30; 1896, Bull. Acad. Imp. Sci. St. Pétersbourg, sér. 5, tome 4, p. 402, plate 1, figs. 1, 3.
Mæotias inexpectata, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 736.

Bell half-egg-shaped, 28 mm. wide, 21 mm. high. Very numerous (300) tentacles thickly set around the margin; with well-developed basal bulbs and slender, filiform shafts; more than 3 times as long as the bell-height. About 100 marginal clubs and 200 lithocysts. Velum very wide. 4 straight, narrow radial-canals and 13 to 15 blindly ending centripetal vessels in each quadrant. Of these, 3 are three-fourths as long as the radial-canals, 4 are about half, and 8 about one-third as long as the radial-canals. All are straight and slender. Stomach without a peduncle and with 4 long, folded, lanceolate lips, which reach level of velar opening. The 4 ribbon-like, sinusoidally folded gonads are developed upon the entire lengths of the 4 radial-canals. Marginal clubs dark-red. Found in the estuaries of the Don and Kuban Rivers, Sea of Azov, Russia.

If there be suctorial disks upon the filiform tentacles, this medusa belongs among the Olindiadæ and is closely related to *Olindias*. Ostrooumoff, however, does not mention suctorial disks and his figures do not show them.

Family LIMNOCNIDIDÆ.

The only species of this family is the remarkable fresh-water medusa, *Limnocnida tanganjicæ* Günther, of Lake Tanganyika, Victoria Nyanza and the Niger, Central Africa.

FAMILY CHARACTERS.

Trachymedusæ with 4 to 6 simple radial-canals. Numerous simple, hollow tentacles, which project from the sides of the exumbrella above the bell-margin. Numerous inclosed lithocysts on the exumbrella side of the velum. Gonads diffusely developed in the ectoderm of the stomach-wall. Mouth a simple, round opening.

Günther states that the concretions are of entodermal origin, but Goto, 1903 (Mark Anniversary Volume), states that Günther's earliest stage in the development of the lithocysts is too far advanced to be of value in determining this point, and he reasons by analogy with *Olindioides* that the concretions may be of ectodermal origin, and the medusa would then be one of the Eucopidæ, whereas Günther places it among the Trachymedusæ. In 1907, however, Günther repeated his observations and decides that the axial cells of the sense-organs, and hence the concretions, are entodermal.

This medusa has no place in Haeckel's system. It has the diffusely developed gonads upon the stomach-wall and the round mouth-opening commonly seen in Narcomedusæ, but its hollow tentacles and inclosed lithocysts throw it out of this order. Its hollow tentacles and the gonad encircling the stomach-wall are characters of the Anthomedusæ, but the lithocysts prevent its being placed among these medusæ. It can not be placed among the Leptomedusæ, for its gonads are not developed upon the radial-canals, and indeed its entodermal concretions and general appearance oblige us to classify it among the Trachymedusæ in close proximity to the Olindiadæ.

It appears to be a highly specialized form which has departed so widely from the type of its salt-water ancestors as to baffle one in any attempt to determine with certainty its closest living relatives. Unfortunately for such purposes, the sexual development remains unknown.

Craspedacusta, another fresh-water medusa, resembles *Limnocnida* in its tentacles and lithocysts, but the mouth is 4-cornered and the gonads are upon the radial-canals. It seems probable, indeed, that *Craspedacusta* is less highly differentiated than *Limnocnida* and represents a generalized ancestral state of the latter. If this be true, the mouth of *Limnocnida* has become a round opening only secondarily and the gonads have only recently come to develop upon the stomach-wall instead of on the radial-canals.

Genus LIMNOCNIDA Günther, 1893.

Limnocnida, Günther, 1893, Annals and Mag. Nat. Hist., ser. 6, vol. 11, p. 274; 1907, Proc. Zool. Soc. London, p. 643.—Goto, 1903, Mark Anniversary Volume, pp. 17, 18.—Gravier, 1907, Bull. Mus. Hist. Nat. Paris, p. 218.

The type species is *Limnocnida tanganjicæ* Günther, of Lake Tanganyika and other fresh waters of Central Africa, where it is abundant from April throughout the summer.

GENERIC CHARACTERS.

Numerous hollow tentacles which project from the sides of the bell above the margin. Tentacles simple, without adhesive disks. Numerous (entodermal ?) sensory-clubs in inclosed capsules on the exumbrella side of the velum under the outer nerve-ring. 4 (occasionally 5 or 6) radial-canals. Mouth a round opening. Stomach-wall short and cylindrical. Gonads in the ectoderm of the stomach-wall. Medusæ are produced by budding upon the wall of the manubrium. Sexual reproduction unknown.

Günther, 1893, 1907, sectioned this medusa and decided that the lithocysts were entodermal, but Goto, 1903, reasoning only by analogy from his studies of *Olindioides*, casts doubt upon this conclusion and believes that they may be ectodermal. Günther would place this medusa among the Trachymedusæ, while Goto would classify it among the Eucopidæ.

The nearest ally of *Limnocnida* appears, curiously enough, to be *Craspedacusta*, another fresh-water medusa. In this form, however, the mouth has 4 principal lobes and the 4 sac-like gonads are developed upon the radial-canals.

Limnocnida tanganjicæ Günther.

Tanganjicæ (medusa of Lake Tanganjika), Böhm, 1883, Sitzungsber. Ges. Nat. Freunde, Berlin, p. 197. See also, von Martens, *Ibid.*

Limnocnida tanganjicæ, Günther, 1893, Annals and Mag. Nat. Hist., ser. 6, vol. 11, p. 269, plates 13, 14, 8 figs.; 1894, Quart. Journ. Microscop. Sci., ser. 2, vol. 36, p. 271, plates 18, 19 (histology); 1907, Proc. Zool. Soc. London, p. 643, text-figs. 172–174, plate 37.—Moore, 1899, Proc. Zool. Soc. London, p. 291; 1903, The Tanganyika Problem, London, pp. 298–308, 6 figs.; 1904, Nature, vol. 69, p. 365.—Notes, 1904, Nature, Lon on, vol. 69, p. 348; *Ibid.*, Moore, p. 365; *Ibid.*, Cunnington, 1906, vol. 73, p. 310.—Potts, 1906, Quart. Journ. Microscop. Sci., vol. 50, p. 623, plate 35, fig. 12.—Browne, 1906, Annals and Mag. Nat. Hist., ser. 7, vol. 17, p. 304; 1908, J. S. Budgett Memorial Volume, Cambridge, p. 471, plate 28, figs. 1–2.

Limnocnida (?), du Guerne, 1893, Bull. Soc. Zool. de France, tome 18, p. 225.

Limnocnida tanganyicæ, Bernard, 1898, Bull. Mus. Hist. Nat. Paris, p. 62.—Gravier, 1903, Bull. Mus. Hist. Nat. Paris, tome 137, p. 867.

Bell lenticular, nearly flat, quite thick at center, about 20 to 25 mm. wide. There are more than 200 hollow tentacles of various lengths, there being when adult 8 or 9 orders of tentacles. The radial, interradial, and adradial tentacles are the oldest and longest. There are no swollen tentacle-bulbs, but the tentacles arise from the ring-canal and project outward from the sides of the bell at some distance above the margin. The tentacles are adherent for some distance, at their bases, to the surface of the exumbrella and are symmetrically arranged in several series of alternating lengths. There are numerous nematocyst-warts, but no adhesive disks upon the tentacles. There are about 250 irregularly arranged lithocysts, consisting of closed capsules near the base of the velum upon the exumbrella side. Each lithocyst contains, according to Günther, a single spherical mass of entodermal cells attached by a stalk to the side of the capsule nearest the ring-canal. These lithocysts lie under the outer nerve-ring.

There are 4 (occasionally 5 to 7) short radial-canals and a simple ring-canal. Stomach is two-thirds as wide as the bell and has short vertical sides, so short that the mouth does not project beyond the velar opening. The mouth is a wide, circular space, always gaping open. The stomach space is partially filled by a lenticular, gelatinous thickening. Medusa-buds are produced in large numbers upon the outer side of the stomach-wall, both ectoderm and

entoderm sharing in their formation. After this asexual process has ceased, gonads are developed in the ectoderm of the stomach-wall. When set free the budded medusa has only 8 short, stiff tentacles, but medusa-buds of another generation begin to develop upon the sides of its manubrium even before the new medusa is set free. The medusa pulsates before being set free and while still attached to the side of the stomach of the parent. Sometimes the medusa-buds, instead of being produced individually, are borne upon branched stolons, which arise from the sides of the stomach. These stolons may break off and their buds cause them to swim about, reminding one of Siphonophoræ. Very soon, however, the pulsating medusæ become detached and swim away separately. The budding process is often so vigorous that the stomach-wall may be nearly destroyed by it.

The gonads and tentacles are white to milky, all other parts being of a glassy transparency.

This medusa is exceedingly abundant in the fresh-water Lake Tanganyika, Central Africa, from May to October, being commonest in June and July. Sexually mature medusæ are found from May to October, but asexually reproducing medusæ are found throughout the year (Günther). The medusa is rare during the wet season, from November to April. The natives call them the "eyes of the lake," and say that the lake sleeps during the wet season and therefore the eyes are not commonly to be found at that time.

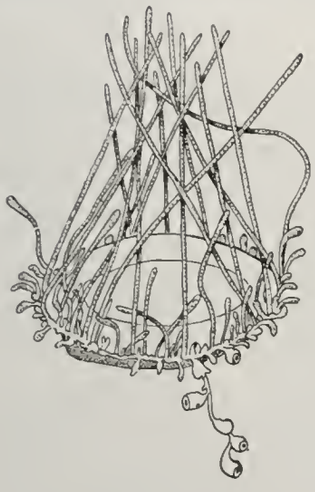


FIG. 211.—*Limnocnida tanganjicæ*, after Moore, in Tanganyica Problem.

Gravier and Moore have found this or a very similar medusa in Lake Victoria Nyanza. It is possible that both Lakes Victoria Nyanza and Tanganyika constituted parts of the Jurassic Sea of Central Africa, or possibly the medusa may have been introduced into Victoria Nyanza by commerce from Tanganyika.

Apparently a similar medusa is found at Sotuba, Niger River, Africa, in lake-like expansions of the river above the rapids (see du Guerne, 1893). Browne, 1906, also records a medusa with more sense-organs and tentacles than those of Lake Tanganyika, in the Forcados River, a fresh-water branch of the Niger, 102 miles from the sea, and in 1908 he describes it from Assay, Delta of the Niger.

Günther, 1907, finds that there appear to be only male medusæ in Lake Tanganyika, whereas in Lake Victoria Nyanza all of the medusæ are females. The medusa of Lake Victoria Nyanza appears to be a subspecies of that of Tanganyika, and Günther, 1907, calls it *L. tanganicæ* var. *victoriæ*. It is about 13 mm. in diameter when adult and the older tentacles are deeply sunken into the gelatinous substance of the bell. Moreover, only the outer two-thirds of the older tentacles are covered with nematocyst-warts.

Günther, 1907, states that the medusæ of Lake Tanganyika have normally 4 radial-canals, but that the number ranges from 4 to 7 and that 24 per cent have 5 or more canals. The supernumerary canals are not caused by a forking of the original 4. The free medusa 2 mm. wide has tentacles of the fifth order just beginning to appear and there are then only 16 lithocyst-vesicles. When the medusa is adult and 22 mm. wide the tentacles of the eighth order and a few of the ninth are present.

Family PTYCHOGASTRIDÆ.

Pectyllidæ, HAECKEL, 1879, Syst. der Medusen, p. 265.

FAMILY CHARACTERS.

Trachymedusæ with marginal tentacles grouped into more or less well-defined clusters. Some of the tentacles bear adhesive disks. There are numerous free sensory-clubs. 8 radial-canals. 4 lips. Stomach 8-lobed, with the lobes in the radii of the 8 radial-canals. These stomach-lobes are bound to the subumbrella by means of 8 mesenterial partitions. The gonads are upon the sides of these 8 stomach-lobes and each gonad is divided, more or less, by the mesentery, so that there may be 8 double (16) gonads.

In 1879, 1881, Haeckel established the family Pectyllidæ for his genera *Pectyllis*, *Pectis*, and *Pectanthis*. Browne, 1903, and Maas, 1906, have shown that Haeckel's account of *Pectyllis* is very erroneous, that his three genera are probably only one, and that Allman's generic name *Ptychogastria* takes precedence over *Pectyllis* Haeckel. The details of these corrections will appear in the following account of the species.

Genus PTYCHOGASTRIA Allman, 1878.

Ptychogastria, Allman, 1878, Hydrozoa, in Nare's Narrative of Voyage to Polar Sea in H. M. S. *Alert* and *Discovery*, vol. 2, p. 290.—Browne, 1903, Bergens Museums Aarbog, No. 4, p. 24.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 492, Jena; 1906, Expédition Antarctique S. Y. *Belgica*, Medusen, p. 7, Anvers.
Pectyllis+*Pectis*+*Pectanthis*, Haeckel, 1879, Syst. der Medusen, pp. 265, 266, 267.
Pectyliss+*Pectis*+*Pectanthis*, Haeckel, 1881, Deep-sea Medusæ, *Challenger* Report, Zool., vol. 4, pp. 10, 15, 19.

The type species is *Ptychogastria polaris* Allman=*Pectyllis arctica* Haeckel, of the Arctic Ocean.

GENERIC CHARACTERS.

Trachymedusæ with numerous isolated clusters of tentacles upon the bell-margin. These tentacles arise in several rows and some of them are provided with suckers, while others lack these appendages. Isolated, single tentacles may arise from the margin between the tentacle-clusters. 8 radial-canals. The ring-canal may give off blindly ending centripetal branches. Mouth quadratic, with 4 lips. The base of the stomach gives rise to 8 lobes, continuous with, and in the radii of, the 8 radial-canals, and these lobes are bound to the subumbrella wall by arch-like mesenteries. The 8 more or less completely cleft gonads are developed upon these stomach-lobes and are more or less separated by the 8 mesenterial partitions, so that there may be 8 double (=16) gonads. There are sensory-clubs upon the bell-margin.

The differences between the genera "*Pectyllis*," "*Pectis*," and "*Pectanthis*," as defined by Haeckel, are so slight as to appear of specific rather than of generic value; moreover, *Pectyllis* Haeckel is certainly identical with the older genus *Ptychogastria* Allman.

Admirable as Haeckel's system of the medusæ is, it appears to me that it lays so much stress upon pointing out distinctions that relationships are frequently obscured. I believe, however, that the chief object of a system should be to indicate relationships; I have, therefore, presumed to broaden the definitions of many of Haeckel's genera, thus greatly reducing their number and bringing closely related forms into closer contiguity one with another in the text, instead of widely separating them, as is often done by Haeckel. From the nature of the conditions, however, these matters are more or less subjective, and one's own opinion changes from time to time even though the data for the definitions of related genera remain the same. It is fortunate for science that with the discovery of the law of evolution the old importance of systems fell to the ground, and to-day systems are of service only in the proportion that they indicate the blood-relationships of forms and present a logical and convenient means of classification.

Ptychogastria polaris Allman.

Ptychogastria polaris, Allman, 1878, Hydrozoa, in Nare's Narrative of Voyage Polar Sea in H. M. S. *Alert* and *Discovery*, vol. 2, p. 290, 3 figs.—Browne, 1903, Bergens Museums Aarbog, No. 4, p. 24, plate 4, figs. 1, 2; plate 5, figs. 6–8.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, pp. 482, 492, 509 (description of medusa and review of literature).—Linko, 1904, Zool. Anzeiger, Bd. 28, p. 218.—Broch, 1907, Report of the Second Norwegian Arctic Expedition in the *Fram*, No. 12, p. 8.
Pectyllis arctica, Haeckel, 1879, Syst. der Medusen, p. 266; 1881, Deep-sea Medusæ, *Challenger* Report, Zool., vol. 4, p. 11, plates 3, 4.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 20.—Grönberg, 1897, Zoolog. Jahrb., Abth. Syst., Bd. 11, p. 465.—Linko, 1900, Soc. Imp. des Naturalistes Travaux, tome 31, p. 117.

Bell hemispherical or more or less conical, with a bluntly rounded, aboral apex. 10 to 15 mm. wide, 9 to 12 mm. high. According to Haeckel and Maas, there are 16 projecting radiating ribs on the exumbrella, alternating with 16 deep grooves. According to Browne, the exumbrella displays "numerous longitudinal ridges," but he does not state their number. Velum very wide, probably capable of nearly closing the opening of bell-cavity. Bell-margin is thickened and beset with about 48 clusters of tentacles; each cluster arises from a triangular thickening upon bell-margin; the tentacles of each cluster are of two sorts and are definitely

arranged. 3 long, filiform tentacles, which lack suckers, arise from the upper apex of the triangular thickening, and there are also a large and variable number of short, sucker-bearing tentacles, which arise from the basal parts of the triangular thickening. The long filiform tentacles taper gradually from base to tip, but the short sucker-bearing tentacles widen outwardly, and usually end in a pad-like sucker, though this is sometimes absent. There are probably 48 long, isolated filiform, suckerless tentacles, alternating with the 48 clusters of tentacles. Altogether there are more than 1,000 tentacles. The "sucking cups" and "short-stalked tentacles" of Haeckel, 1881, are only broken tentacles or basal remnants of tentacles, for they appear to be quite brittle, as is commonly the case in Trachymedusæ.

There are 16 marginal sensory-clubs, 2 in each octant, arising from the inner side of the bell-margin immediately under a group of sucker-bearing tentacles. The sensory-club is very

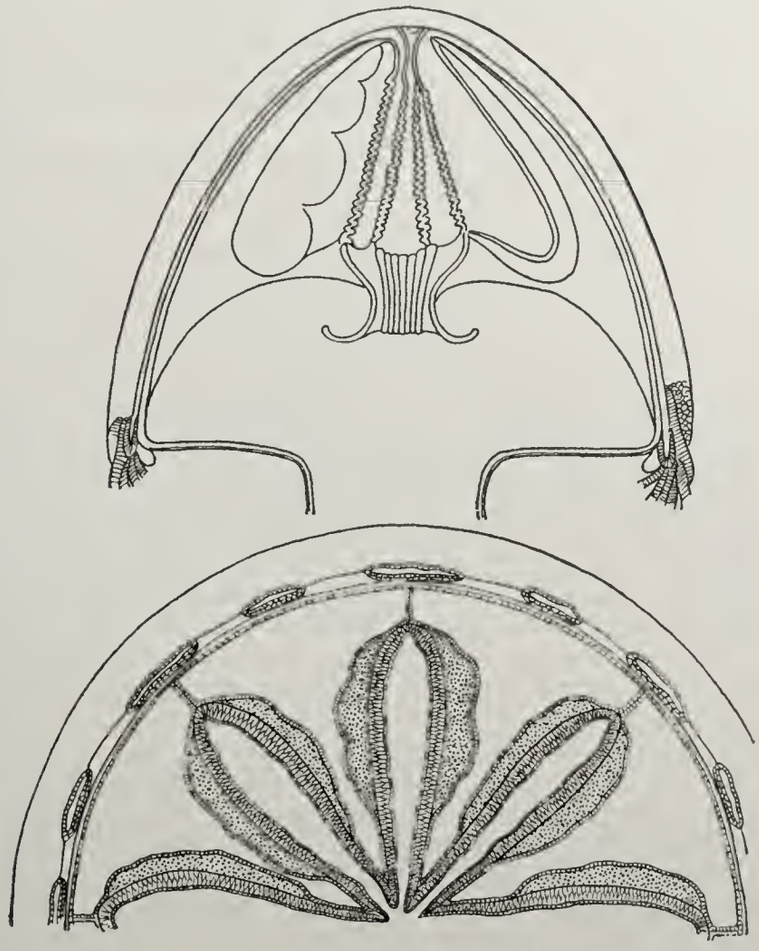


FIG. 212.—*Ptychogastria polaris*, after Browne, in Bergens Museums Aarbog, 1903. Above: Diagrammatic side view. Below: Diagrammatic cross-section of bell.

small, mounted upon a short stalk, and contains a single concretion. There are 8 radial-canals. These are not very wide upon leaving the stomach, but they widen outwardly and become very broad and flat where they join the ring-canal. The ring-canal is also very broad and gives off 8 broad, flat, centripetal vessels which alternate with the radial-canals and taper to fine points near the edge of the stomach. There is a thick layer of circular muscle fibers over the subumbrella and the canal-system lies under this muscular system.

Stomach about half as long as depth of bell-cavity, vase-shaped, 8-rayed above; each of the 8 stomach pouches is bound to the subumbrella by a mesentery along the line of the corresponding radial-canal. Mouth-tube quadrate, with 4 lips; 4 of the stomach-lobes are in the radii of the lips and 4 are interradial. There are 16 separated gonads along the sides of the 8 stomach lobes, on both sides of the 8 radial mesenteries. The gonads are not developed upon the radial-canals, but are confined to the sides of the 8 rays of the stomach and completely

separated one from another by the mesenterial partitions which form groined arches uniting the 8 stomach-rays to the subumbrella and extending outward to bell-margin. We may therefore speak of the gonads as 8 double, genital organs divided by 8 median partitions into 16 separated gonads. Maas regards the 8 stomach-pouches as the basal parts of the radial-canals, and if this view be true the gonads may be considered as being on the sides of the gastric regions of the radial-canals. The development of this medusa is, however, entirely unknown, and this point can only be determined through studies of the ontogeny.

This is an Arctic species. Haeckel records it from a depth of 1,250 fathoms off Nova Scotia and off the west coast of Greenland. Grönberg found it off the coast of Spitzbergen, where it occurs within 10 to 30 fathoms of the surface. Browne records it from the Arctic coast of Norway, between depths of 250 fathoms and the surface. Levinsen, 1893, Maas, 1893, and Aurivillius, 1899, record it from the coasts of Greenland. Linko, 1900, 1904, found it off the Murman coast, northern Russia, and Maas, 1906, near King Charles Land from depths between 25 to 75 fathoms. It appears to be common along Arctic coasts.

Browne, 1903, gives the best modern account of this medusa and has corrected several serious errors in Haeckel's, 1881, description.

Broch records this medusa from a depth of less than 43 fathoms at Winterhafn, and it is evident that this species can not be called a "deep-sea medusa."

Ptychogastria asteroides Browne Maas.

Pectanthis asteroides, Haeckel, 1879, Syst. der Medusen, p. 267; 1881, Report *Challenger* Expedition, Zool., vol. 4, p. 20, plates 7, 8; figs. 1–10.
(*Ptychogastria?*) *asteroides*, Browne, 1903, Bergens Museums Aarbog, No. 4, p. 29.
Ptychogastria asteroides, Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 492, Jena.

Bell about 4 to 5 mm. wide, flatter than a hemisphere, with fairly thin, gelatinous walls and a small, solid, sharply pointed, apical projection. 16 raised, radiating ridges extend from center of exumbrella to margin; of these, 4 are radial, 4 interradial, and 8 adradial. The 8 radial and interradial ridges are each marked by a streak of purple-red, which expands into a large spot at the margin. All 16 ridges bear nematocysts. The margin exhibits 16 rounded lobes, alternating with the 16 ridges of the exumbrella. This margin is thickened by a considerable development of nematocysts, the inner border of which is black, ciliated, and sinuous, with about 8 to 10 short sinuosities in each lappet. There are 16 isolated, short, bluntly conical tentacles, one in each of the 16 niches between the marginal lobes and in the radii of the 16 exumbrella ridges. At the center of the margin of each lobe, alternating with the exumbrella ridges, is a single lithocyst. These 16 lithocysts are short and club-shaped and each contains a terminal spherical concretion of entodermal origin.

There are 200 to 260 tentacles, which arise in 16 clusters from the 16 marginal lobes on both sides of the 16 lithocysts. These tentacles are hollow, flexible, and usually somewhat shorter than the radius of the bell, although they are capable of great extension. Nearly all of the tentacles are provided with a terminal sucker, and their general appearance is strongly suggestive of the ambulacral tube-feet of echinoderms. The medusæ may attach themselves by means of the terminal suckers of their tentacles and may then climb upward as would a star-fish. Frequently the medusa lies upon the bottom with its exumbrella downward and is then anchored by some of its suctorial tentacles while others wave freely about in the water. A few of the tentacles have simple, pointed ends without terminal suckers.

Velum thick and provided with powerful circular muscles. It can be contracted so as to close the opening of the bell-cavity, like a sphincter. The central stomach is 4-sided and gives rise to 8 straight, slender radial-canals, 4 radial and 4 interradial. These 8 canals extend to the marginal ring-canal in the radii of 8 alternate notches between alternate lappets of the bell-margin.

The 8 radial-canals are bound to the sides of the stomach by 8 well-developed septa, forming 8 shelf-like, radiating partitions on wall of subumbrella. The 8 egg-shaped gonads are developed upon the proximal thirds of the 8 radial-canals closely adjacent to the wall of the stomach. Each of these 8 gonads is bound across its middle axial line by the mesenterial septum which extends from along the radial-canal to the stomach-wall. Each gonad contains a single, central lumen connected with the radial-canal. The stomach is a simple, narrow,

elongate, 4-sided prism, the mouth projecting slightly beyond the velar opening and provided with 4 simple lips. The 8 radial and interradial, radiating ridges of the exumbrella are red, with an expanded red spot at the margin. There is a yellow spot on the exumbrella at each of the 16 notches of the 16 marginal lappets. The suckers of the tentacles are tipped with red. The entoderm of the stomach is golden-yellow and the gonads are red. The subumbrella contains some brown pigment.

Haeckel found a single male specimen of this medusa between 200 fathoms and the surface near Pola in the Adriatic Sea, and later the *Challenger* dredged one from between 600 fathoms and the surface in the entrance to the Straits of Gibraltar. Haeckel, 1881, presents beautiful figures of the medusa.

Ptychogastria antarctica Browne, Maas.

Pectis antarctica, Haeckel, 1879, Syst. der Medusen, p. 266; 1881, Report *Challenger* Expedition, Zool., vol. 4, p. 15, plates 5, 6; figs. 1–20.
(*Ptychogastria?*) *antarctica*, Browne, 1903, Bergens Museums Aarbog, No. 4, p. 29.
Ptychogastria, Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 493, Jena.

Bell 36 mm. wide, 24 mm. high. Apex thick-walled and dome-like, separated by a deep, annular furrow from the thin-walled, flaring, lower part of bell. The exumbrella is traversed from margin to apex by 5 rib-like thickenings; 500 to 600 of these furrows at margin and 32 more prominent, radial ribs running the whole length, and 32 less prominent ridges alternating with them. Gelatinous substance thick in dome, but thin in the flaring side walls below annular furrow. It is especially thick at apex of dome, where it sends a conical projection downward into stomach-cavity.

Bell-margin thickly beset with several rows of tentacles and suctorial disks arranged in 8 larger and 32 smaller groups; and alternating with these in position and arising from the exumbrella, some distance above the other groups, are 40 large, isolated "suckers."* Each smaller group of marginal appendages consists of an upper cluster of 16 to 20 short-stalked "*suctorial* cups,"* and below these are 12 to 16 tentacles, which may or may not terminate in a sucker. The entoderm of these tentacles is composed of solid chordate cells. Most of the tentacles were broken off in the specimen studied by Haeckel. The 8 to 16(?) lithocysts lie on the axial side of the bell-margin under the velum, inside of the lowest row of marginal tentacles.

The velum is so wide that it can probably completely close the bell-opening. It is pigmented and its subumbrella side contains powerfully developed ring-muscles. There are 8 radial-canals, and a ring-canal which gives off 11 to 13 short, blindly ending, centripetal canals in each octant; of these 3 are large and 8 to 10 are smaller. These centripetal vessels are straight and simple and taper to pointed ends.

The manubrium lacks a peduncle and is about half as long as the depth of the bell-cavity, and its mouth is 4-sided and provided with 4 flaring, muscular lips. Longitudinal muscles extend down the manubrium to the 4 radial angles of the lips, while between them there is a powerfully developed system of circular muscles. The stomach gives rise to 16 evaginated, hollow pouches arranged in pairs on both sides of 8 longitudinal furrows which extend down the adradii of the stomach to the zone of the 16 pouches, which are only a short distance above the mouth-opening. Between each pair of evaginated pouches in each of the 8 adradii there is a sharp-pointed conical invagination of the stomach-wall. The 8 swollen, folded, oval gonads occupy the proximal halves of the 8 radial-canals near periphery of stomach, with which they are connected by 8 poorly developed mesenteries. The ectoderm of subumbrella contains dark violet-brown pigment, through which the 8 radial-canals stand out as milk-white lines.

A single specimen was found by the *Challenger* Expedition in the Antarctic Ocean, S. S. E. from Kerguelen Island, at a depth of 1,260 fathoms.

*These so-called "suckers" and "*suctorial* cups" are doubtless only broken tentacles.

Family TRACHYNEMIDÆ Gegenbaur 1856.

Trachynemidæ, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 218.
Trachynemidæ + Aglauridæ, Haeckel, 1879, Syst. der Medusen, pp. 255, 268.

FAMILY CHARACTERS.

Trachymedusæ with 8 or more simple radial-canals, on some or all of which the gonads are developed. No mesenterial partitions in the subumbrella. Tentacles without adhesive disks. Ring-canal simple and without centripetal branches.

We may distinguish two subfamilies: (1) Rhopaloneminæ, in which the stomach lacks a peduncle; and (2) Aglaurinæ, in which the stomach is mounted upon a gelatinous peduncle.

The genera are as follows:

Subfamily Rhopaloneminæ: Trachynemidæ in which the stomach lacks a peduncle.

Rhopalonema Gegenbaur, 1856=*Trachynema* (young medusa, Gegenbaur, 1854)=*Trachynema*+*Rhopalonema*+*Marmanema* Haeckel, 1879. With 8 well-developed, radial tentacles and 8 or more small, cirrus-like or club-shaped, interradial tentacles. All tentacles arise in a single row. 8 gonads localized on the 8 radial-canals. 4 lips.

Sminthea Gegenbaur, 1856. Similar to *Rhopalonema*, but with only 8 tentacles, one at foot of each of the 8 radial-canals.

Homœonema Maas, 1893=*Colobonema* Vanhöffen, 1902=*Isonema* (in part) Maas, 1906. Similar to *Rhopalonema*, but the tentacles are all of one sort. No small, club-shaped or cirrus-like tentacles. 4 lips.

Tetrorchis Bigelow, H. B., 1909. 8 radial-canals, 4 gonads, 4 lips.

Pantachogon Maas, 1893. Gonads not localized as in *Homœonema* and *Rhopalonema*, but diffusely developed over the radial-canals. 4 lips.

Halicreas Fewkes, 1882=*Halicreas*+*Haliscera* Vanhöffen, 1902=*Isonema* (in part) Maas, 1906. The mouth is a simple round opening without 4 lips. (In all known species the radial-canals and ring-canal are very broad and flat.) Wart-like protuberances may be present upon the sides of the exumbrella. Radial tentacles large; interradial, small. Tentacles arise in a single row. Each tentacle terminates in a stiff, bristle-like outer end.

Halitrephes Bigelow, H. B., 1909. Similar to *Halicreas* but with more than 8 radial-canals.

Botrynema Browne, 1908. Similar to *Halicreas*, but the tentacles are grouped into clusters; the tentacles of each cluster arise in a single linear row from the bell-margin.

Crossota Vanhöffen, 1902. The tentacles arise in several rows from the bell-margin. Mouth with 4 lips.

Subfamily Aglaurinæ: Trachynemidæ in which the stomach is mounted upon a peduncle.

Aglaura Péron and Lesueur, 1809. 8 gonads on peduncle above stomach. Sexes separate. Development direct.

Aglantha=*Aglantha*+*Agiscra* Haeckel, 1879. 8 gonads on subumbrella, or at turning-points of the 8 radial-canals between the peduncle and the subumbrella. Sexes separate.

Amphogona Browne, 1904. Similar to *Aglantha*, but the medusa may be bisexual, 4 of the gonads being male and 4 female.

Stauraglaura Haeckel, 1879. 4 gonads, one upon each alternate radial-canal.

Persa McCrady, 1857. 2 gonads on 2 of the radial-canals 180° apart. The 6 other radial-canals are sterile.

Subfamily RHOPALONEMINÆ.

Genus RHOPALONEMA Gegenbaur, 1856.

Trachynema, Gegenbaur, 1854, Zur Lehre Generationswechsel Medusen, Würzburg, p. 53 (young medusa without gonads).
Trachynema+*Rhopalonema*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, pp. 245–251.
Calyptra, Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 14.
Trachynema (in part)+*Marmanema*+*Rhopalonema*, Haeckel, 1879, Syst. der Medusen, pp. 259–264.
Trachynema+*Rhopalonema*, Maas, 1893, Ergebnisse der Plankton Exped., Bd. 2, K. c., pp. 12–18.
Rhopalonema, Vanhöffen, 1902, Wissen. Ergeb. Deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 59.
Rhopalonema, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 27.—Bigelow, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 127.

The type species is *Rhopalonema velatum* Gegenbaur, 1856. The young of this species was probably described by Gegenbaur in 1854 under the name *Trachynema ciliatum*. This medusa is distributed throughout the tropical and warm oceans of the world, but Gegenbaur described it from the Mediterranean.

GENERIC CHARACTERS.

Trachymedusæ, with 8 well-developed, radially placed tentacles and 8 or more club-shaped or cirrus-like tentacles which arise from the bell-margin between the radial-canals. All of the tentacles arise in a single row from the bell-margin. The 8 gonads occur upon restricted portions of the 8 radial-canals. 4 lips. Stomach without a peduncle. Lithocysts inclosed.

Haeckel, 1879, distinguishes three genera in a sense equivalent to our *Rhopalonema*, thus: *Trachynema*, with 4 lithocysts, *Marmanema* with 8, *Rhopalonema* with 16.

The marginal lithocysts, however, increase with age, and when young the medusæ have but 4, then 8, and, finally, 16 or more. Moreover, they are very irregular and variable in their development and are readily lost, and I have seen medusæ in which one octant exhibited the characters of "*Rhopalonema*" while the other 7 octants remained in the "*Trachynema*" stage.

Maas, 1893, 1897, 1904, and 1905, restricts *Rhopalonema* to include medusæ with two different sorts of marginal tentacles, as we have defined them. In contrast to this he introduces a new genus, *Homœonema*, to include medusæ with tentacles all alike, but bearing no definite numerical relation to the radial-canals. Both of these genera have the 8 gonads restricted to definite, limited portions of the 8 radial-canals; and Maas defines another genus, *Pantachogon*, to include medusæ with gonads diffusely developed upon the entire lengths of the radial-canals, while in *Rhopalonema* and *Homœonema* they are localized. I define *Rhopalonema* in the sense proposed by Vanhöffen, 1902.

Tabular Synopsis of the Species of Rhopalonema.

	R. velatum Gegenbaur, 1856.	R. polydactylum Haeckel = Homœonema elongatum Maas.	R. cœruleum Haeckel, 1879; Maas, 1905 = R. funerarum Vanhöffen, 1902 = (?) Dianea funeraria Quoy et Gaimard, 1817.	R. striatum Maas, 1893.	R. clavigerum = Marmanema clavigerum Haeckel, 1879
Shape and size of bell in mm.	Hemispherical, often with low dome-like apex. 8 to 15 mm. wide.	Pyriform. 10 wide, 8 high.	Higher than a hemisphere when mature. 12 to 17 wide, 7 to 14 high.	Flat, Chinese hat-shaped. 4 wide, 1 high.	Hemispherical with low, dome-like apex. 7 wide.
Number and character of tentacles.	32. 8 long club-like radial + 8 smaller interradial + 8 small cirrus-like adradial.	32. 16 long club-shaped radial and interradial, 16 short, stiff, cirrus-like adradial.	32. As in R. velatum.	16. 8 large radial + 8 small interradial.	16. 8 long radial + 8 interradial cirri.
Number and arrangement of lithocysts.	8 to 16, or 2 in each octant. Near interradial cirri.	16, near adradial tentacles.	32. Alternating with the 32 tentacles. Not close to interradial cirri as in R. velatum.	16+ alternating with tentacles.	8 close to, and clockwise away from, interradial cirri.
Length of manubrium in terms of depth of bell-cavity.	0.5	1.5	0.25	0.5	1 ±
Position of gonads on 8 radial-canals.	Restricted to middle thirds. Spindle-shaped, narrow.	Restricted to middle thirds. Spindle-shaped, narrow.	On outer two-thirds of radial-canals. Spindle-shaped, narrow.	From middle to inner thirds of radial-canals near stomach.	On proximal halves of radial-canals adjacent to stomach. Spindle-shaped.
Color.	Stomach and gonads milky-white. Tips of tentacles often red.	Colorless.	Iridescent, colorless, or sky-blue.	Colorless?	Of a glassy transparency.
Where found.	All tropical and warm seas. Near surface.	Mediterranean, Sea of Marmora.	A deep-sea form found in tropical Atlantic, Pacific, Indian Oceans and Mediterranean. Not common on the surface.	Bermudas, Sargasso Sea; tropical Atlantic.	Tropical Atlantic. On surface.
Distinctive characters.	Gonads restricted to middle thirds of radial-canals. Manubrium only about half as long as depth of bell-cavity.	Gonads as in R. velatum. Manubrium very long, 1.5 times as long as depth of bell-cavity. Colorless. Lithocysts near adradial cirrus-like tentacles.	Gonads restricted to outer two-thirds of radial-canals. 32 tentacles alternating with 32 lithocysts. Gonads do not begin to develop in R. cœruleum until medusa is 6 to 7 mm. wide.	Gonads from middle to inner one-third of radial-canals. 16 lithocysts alternating with 16 tentacles.	Gonads on inner halves of radial-canals adjacent to stomach. 8 lithocysts close to bases of 8 interradial cirri.

Rhopalonema velatum Gegenbaur.

Trachynema ciliatum (young medusa), Gegenbaur, 1854, Zur. Lehre Generationswechsel bei Medusen, p. 52, taf. 2, fign. 17–23; 1856, Zeit. für wissen. Zool., Bd. 8, p. 249, taf. 9, fig. 6.

Rhopalonema velatum, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 251, taf. 9, fign. 1–5 (mature medusa).—Haeckel, 1879, Syst. der Medusen, p. 264.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 14, taf. 1, fign. 5, 9–11.—1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 27; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 50, taf. 10, fig. 69.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 59, taf. 10, fign. 16, 28; taf. 11, fig. 32.—Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 61 (segmentation and formation of entoderm), taf. 6, fign. 13–15.—Maas, 1906, Revue Suisse de Zool., tome 14, p. 97.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 129.

Trachynema octonarium (young medusa), Haeckel, *Ibid.*, p. 260.

Marmanema tympanum (medusa with mouth lost through accident), Haeckel, *Ibid.*, p. 262.

(?) *Calyptra umbilicata*, Leuckart, 1856, Archiv. für Naturges., Jahrg. 22, p. 14, taf. 1, fign. 9, 10=*Marmanema umbilicatum*, Haeckel, 1879, Syst. der Medusen, p. 263.

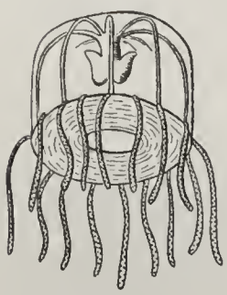
Marmanema velatoides, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 13, taf. 1, fig. 6.

Rhopalonema typicum, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 152, plate 5, figs. 21, 22.—Hargitt, 1902, Biol. Bulletin, vol. 4, p. 14, fig. 2; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 54, 1 fig.

(?) *Sminthea eurygaster* (young medusa), Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien., Bd. 6, p. 244, taf. 22, fign. 17, 20.

Bell hemispherical, often with a low, solid, dome-like apical projection, 8 to 15 mm. wide, with thin but quite rigid walls. 8 straight, narrow radial-canals, 4 perradial and 4 interradial, 8 marginal tentacles at bases of the 8 radial-canals. These tentacles are twice as long as bell-diameter and have enlarged, spindle-shaped distal ends. There are 1 to 3 smaller tentacles in each octant between the radial-canals. These are less than one-fourth as long as the 8 principal tentacles and are more like cirri with club-shaped ends. There are thus altogether 32 tentacles, 8 at the bases of the radial-canals and 24 (3×8) spaced at equal distances around the margin between the radial-canals. All of the tentacles are very brittle and are usually broken off short in specimens taken in a tow-net. They are all solid, their entoderm being composed of chordate cells.

In young medusæ there are only 4 lithocysts, one in the middle of every alternate octant between radial-canals, but when older there are 8 lithocysts, one near the middle of each octant, and the lithocysts finally increase to 16, which follow in clock-wise rotation close to



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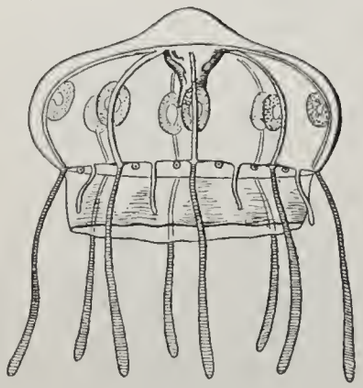

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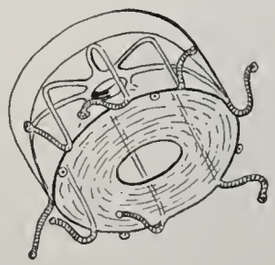

215.

Fig. 213.—"*Trachynema ciliatum*"=young of *Rhopalonema velatum*.
Fig. 214.—*Rhopalonema velatum*.
Fig. 215.—"*Sminthea tympanum*,"=Young stage of *Rhopalonema velatum*.
Above figures after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

the points of origin of the perradial and interradial tentacles. Each mature lithocyst is a simple, closed, marginal vesicle containing a sensory-club with a single spherical concretion of entodermal origin. When young, however, the lithocyst-club is naked and it is only later that the ectodermal capsule grows outward from the bell-margin and forms a crater-like wall around the club.

Stomach small and short, only about half as long as depth of bell-cavity; octagonal above, 4-sided below; 4 simple, short lips in the radii of 4 of the radial-canals. The gonads are 8 linear to egg-shaped pouches restricted to the middle thirds of the 8 radial-canals. They begin to develop when the medusa is about 4 mm. wide.

Stomach and gonads milky-white; tentacles carmine, specially at their tips.

This medusa was first adequately described by Gegenbaur and Haeckel from the Mediterranean, where it is exceedingly abundant. Since then it has been found widely distributed over the tropical Atlantic, Pacific, and Indian oceans. It is a surface form and appears not to

have been found at great depths, excepting by Chun in the Mediterranean. Hargitt found it in the Gulf Stream off Woods Hole, Massachusetts. It is well known that the Mediterranean is warmer (12.6° to 13.6° C.) at great depths than is the Atlantic or Pacific and this may readily account for the peculiar distribution of *R. velatum* in this sea. This species is distinguished by its small gonads restricted to the middle thirds of the radial-canals and its short stomach. The red color of the tentacles is not so distinctive, being quite variable in hue, or even wanting. (See text-figure 218.)

Rhopalonema umbilicata=*Calyptra umbilicata* Leuckart, 1856, is probably identical with *R. velatum*. It is found in the Mediterranean and the tentacles are whitish, not red; also, the manubrium is apparently as long as the depth of the bell-cavity, but the bell is represented as expanded. Vanhöffen, 1902, and Maas, 1905, regarded it as being identical with *R. velatum*.

Rhopalonema typicum Agassiz and Mayer, 1902, from the eastern parts of the tropical Pacific, is doubtless identical with *R. velatum*. It is larger than the typical *R. velatum*, being 15 mm. wide, and there is a well-developed apical projection at the center of the exumbrella. There are about 16 lithocysts and 32 tentacles as in *R. velatum*; and the length of the stomach and position of the gonads on the middle of the radial-canals are identical with *R. velatum*. The tentacles are milky in color, not red as in the typical *R. velatum*. We may consider it to be a large, relatively colorless variety of *R. velatum*. It is very abundant in the tropical Pacific. (See text-figure 219.)

The development has been studied by Gegenbaur, 1854, and Metschnikoff, 1886. The egg is 0.24 mm. in diameter and is discharged into the water during the daytime. It remains suspended in the water, neither sinking nor rising. Segmentation is total and equal and a solid morula is formed, the central cells of which become entoderm, while the outside layer forms the ectoderm.

Gegenbaur, 1854, probably had the young medusa of this species, calling it "*Trachynema ciliatum*." When 1 mm. wide there were 4 ciliated, radially placed tentacles alternating with 4 interradial sensory-clubs. The whole surface was ciliated and there were but 2 lips, these being 180° apart. The second pair of lips do not develop until after the larva has 16 tentacles. They then develop, forming a cross with the first pair. (See text-figure 213.)

It is interesting to see that Metschnikoff finds that the young medusa of *Aglaura hemistoma* has also but 2 lips 180° apart.

A larval *Cunina* is often found attached to the subumbrella of *R. velatum* at Naples, Italy.

Rhopalonema polydactylum Haeckel.

Rhopalonema polydactylum, Haeckel, 1879, Syst. der Medusen, p. 265, taf. 17, fign. 7–11.
Homœonema elongatum, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 20.

Bell pyriform to conical, with a narrow, rounded apex. It is 10 mm. wide, 8 mm. high. 32 tentacles of unequal length. The 16 larger, radial and interradial tentacles are as long as the bell-radius; their outer ends are club-like and their epithelium is covered with cilia. The 16

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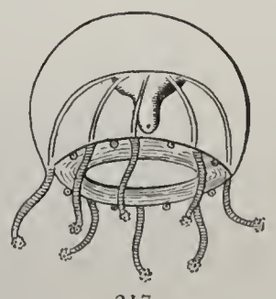


217.

Fig. 216.—*Rhopalonema velatum*. Young medusa showing the free sense-club not yet inclosed within a capsule. From life, by the author, Naples Zoological Station. Showing an enlarged view of the naked sense-club. In later life this club becomes partially inclosed within an open crater-like capsule.

Fig. 217.—"*Sminthea globosa*," after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8=An immature stage of *Rhopalonema velatum*.

smaller tentacles are adradial and only about half as wide and as long as the other tentacles. They are stiff and their outer ends are club-shaped and bear a ring of long, stiff bristles. The 16 lithocysts, near the bases of the adradial tentacles, are closed marginal vesicles, each containing a pear-shaped sensory-club, with a single spherical concretion. Velum narrow. The 8 radial-canals and the ring-canal are quite wide and are simple and straight-edged.

The most characteristic feature of this species is the great length of the stomach, which is about 1.5 times as long as depth of bell-cavity. It is narrow, cylindrical, and has 4 large, bluntly-rounded lips. The gonads are developed upon the middle points of the 8 radial-canals and are restricted to the middle one-fourth to one-third of each canal. These gonads are spindle-shaped and are developed upon both sides of each canal. Males only were found by Haeckel. The medusa is glassy and colorless. Found in the Mediterranean, Sea of Marmora. (See text-figure 220.)

Rhopalonema cœruleum Haeckel.

(?) *Dianæa funeraria*, Quoy et Gaimard, 1817, Annal. des Sci. Nat., tome 10, plate 6, figs. 10–15 (an abnormal specimen with 7 canals).

Rhopalonema cœruleum, Haeckel, 1879, Syst. der Medusen, p. 264, taf. 17, fign. 3–6.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 51, taf. 10, fign. 67, 68.—Browne, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 172; Fowler, *Ibid.*, p. 182.

(?) *Rhopalonema funerarium*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 28.

Rhopalonema funerarium, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 61, taf. 9, fig. 2; taf. 10, fig. 17; taf. 11, fig. 31.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 132.

Bell 17 mm. wide, 14 mm. high. Walls moderately thin, thicker at apex. 8 radial-canals. 16 tentacles: 8 radial, 8 interradial. 16 adradial cirri and 32 marginal lithocysts at equal distances between the tentacles and cirri. Stomach short, with 4 simple lips. 8 elongate,

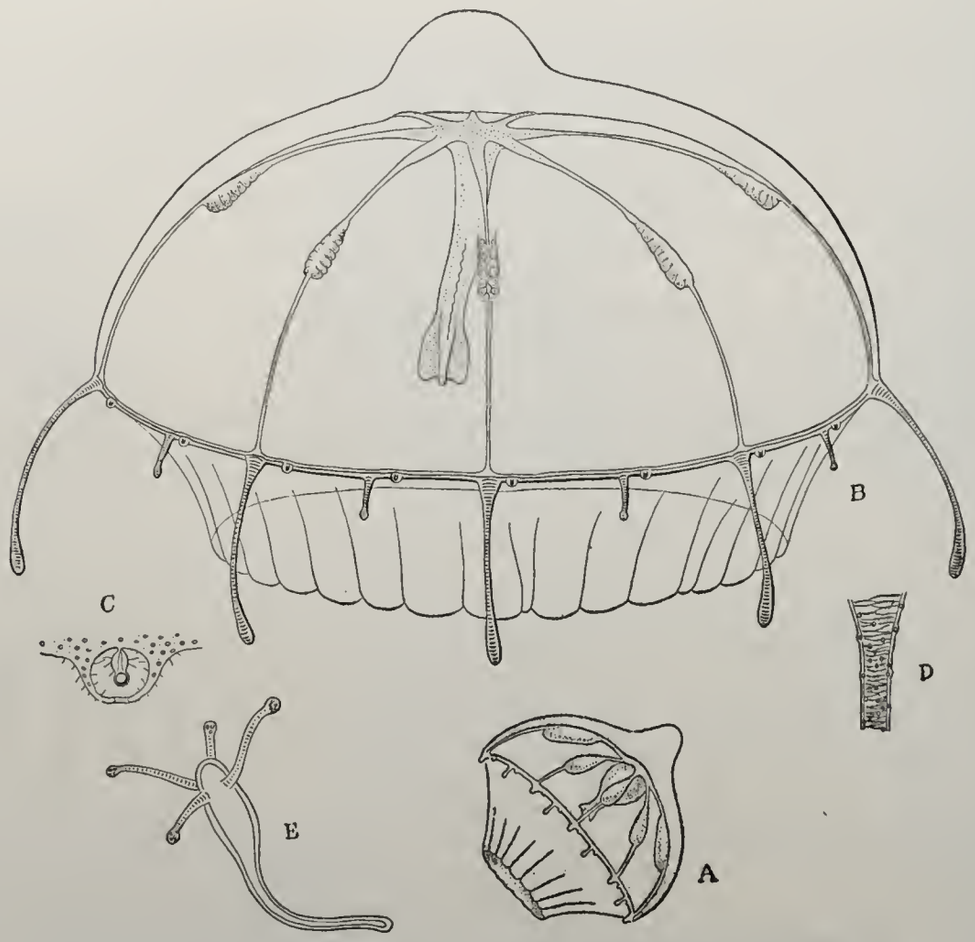


Fig. 218.—*Rhopalonema velatum*. *A*, mature medusa; *B*, enlarged view of half-grown medusa; *C*, sensory-club within its wall-like capsule; *D*, part of tentacle; *E*, cunina larva ectoparasitic on subumbrella of *Rhopalonema*. From life, by the author, Naples Zoological Station, December, 1907.

egg-shaped gonads on outer two-thirds of the 8 radial-canals. Colorless, iridescent, or sky-blue. Tropical Atlantic, Indian, and Pacific Oceans, and Mediterranean. Not common at the surface, but abundant at a depth of 100 fathoms. The gonads begin to develop when the medusa is 6 to 7 mm. wide. Vanhöffen, 1902, presents beautiful figures of this medusa.

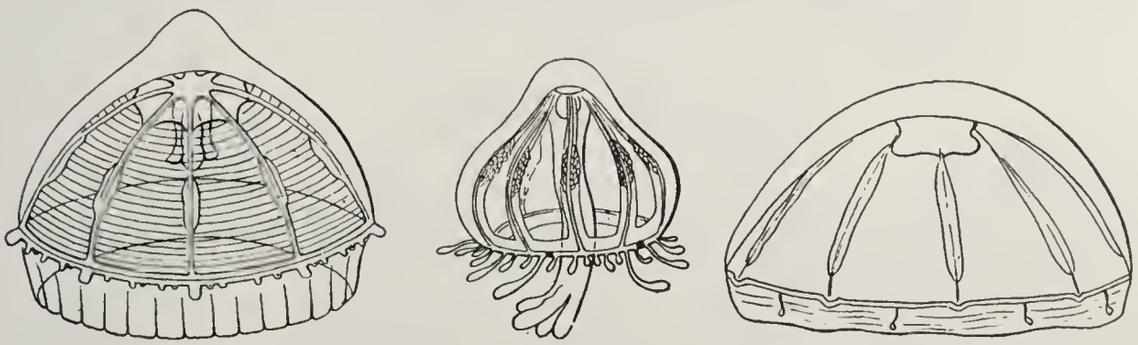
Bigelow, 1909, records the capture of 11 specimens at depths between 300 fathoms and the surface, in the Humboldt Current, off the western coast of tropical South America.

It will never be possible to specifically determine Quoy and Gaimard's *D. funeraria*, and I therefore believe that confusion will be avoided by dropping this specific name and accepting the name *R. cæruleum* of Haeckel and of Maas. (See text-figures 221 to 223.)

Rhopalonema striatum Maas.

Rhopalonema striatum, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 15, taf. 1, figs. 3, 4.

Bell flat, the shape of a Chinese hat, 4 mm. wide and 1 mm. high. 16 tentacles: 8 large radial, 8 small interradial. 16 or more lithocysts alternating with the tentacles. 8 wide, spin-

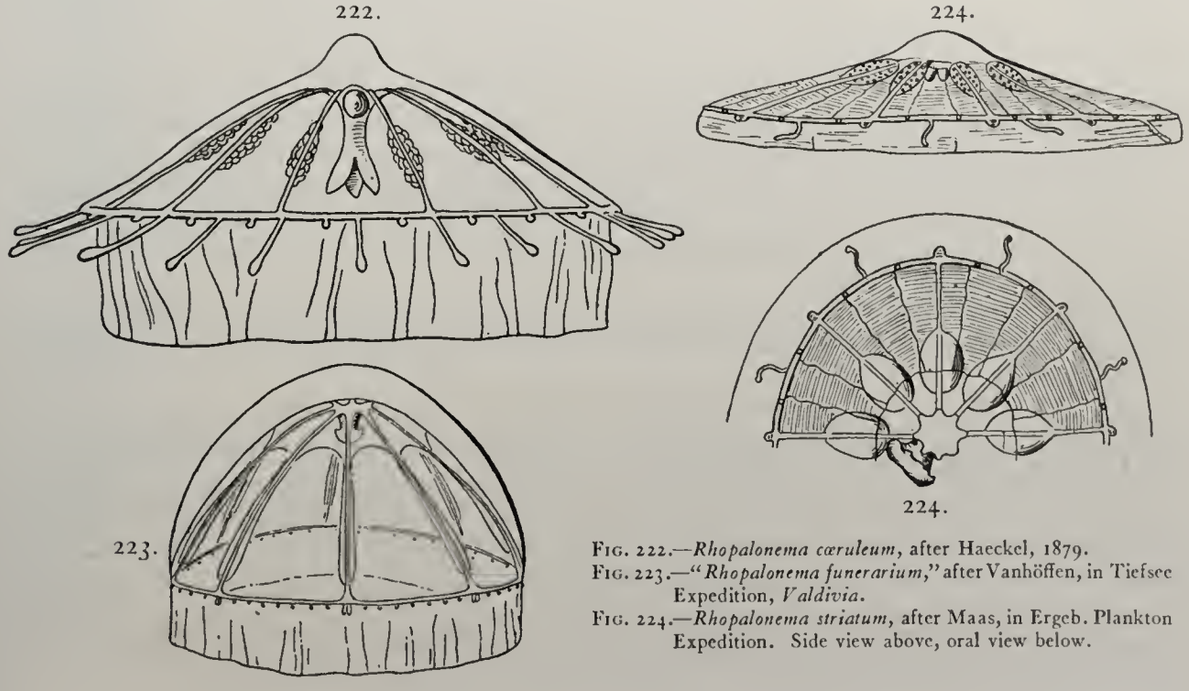


219. 220. 221.

Fig. 219.—*Rhopalonema velatum*, after Agassiz and Mayer, in Mem. Museum of Comp. Zool. at Harvard College.
Fig. 220.—*Rhopalonema polydactylum*, after Haeckel, 1879.
Fig. 221.—*Rhopalonema cæruleum*, after Maas, in Hydromedusen *Siboga* Expedition.

dle-shaped gonads, extending along the middle of inner thirds of the 8 radial-canals. Velum large. Stomach very short. Mouth with 4 simple lips. Bermudas to Sargasso Sea, tropical Atlantic. Described by Maas from preserved specimens. The flat, expanded shape of the bell may be due to unnatural distortion. (See text-figures 224.)

222. 224.



223. 224.

Fig. 222.—*Rhopalonema cæruleum*, after Haeckel, 1879.
Fig. 223.—"*Rhopalonema funerarium*," after Vanhöffen, in Tiefsee Expedition, *Valdivia*.
Fig. 224.—*Rhopalonema striatum*, after Maas, in Ergeb. Plankton Expedition. Side view above, oral view below.

Rhopalonema clavigerum.

Plate 49, figs. 1 to 1″.

Marmanema clavigerum, Haeckel, 1879, Syst. der Medusen, p. 263, taf. 17, fign. 1, 2.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 13.

The bell is hemispherical, with a bluntly-rounded, apical projection, and about 7 mm. wide. 16 tentacles, 8 of which are radial and are 2 to 3 times as long as the bell-diameter, with swollen, tapering, club-shaped, ciliated outer ends. The 8 interradial tentacles are mere slender, short, filiform cirri about half as long as the bell-radius. 8 lithocysts close to the sides of the 8 interradial cirri. Viewing the medusa from the oral side so as to look into the bell-cavity, the lithocysts are always in the direction in which the hands of a watch would move from the interradial cirri to the lithocysts. Each lithocyst is a closed vesicle, within which we find a club with a narrow stalk, and this club contains a single spherical concretion.

The velum is very wide and muscular and swings to and fro within and without the bell-cavity as the medusa swims. In common with other species of *Rhopalonema*, the medusa gives a series of very rapid, powerful pulsations alternating with periods of complete rest.

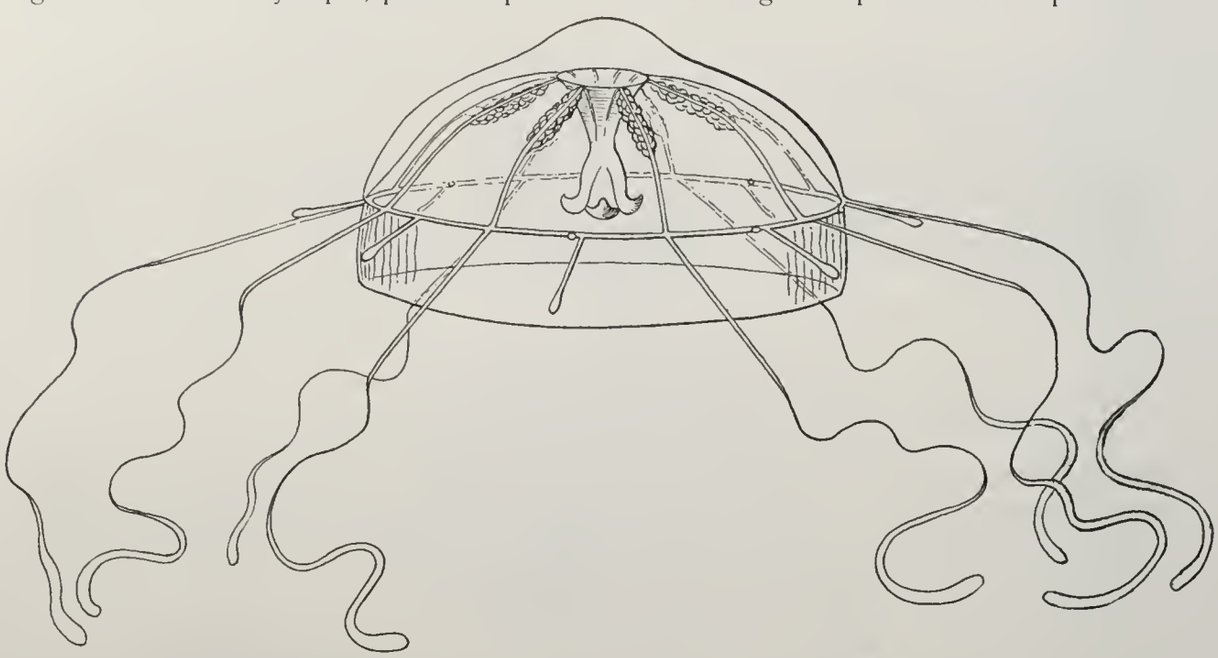


Fig. 225.—*Rhopalonema clavigerum*, after Haeckel, in System der Medusen.

Stomach about as long as depth of bell-cavity; 4 short, simple lips. 8 spindle-shaped gonads are developed upon the proximal halves of the 8 radial-canals adjacent to base of stomach.

The whole medusa is of a glassy transparency, rendering it all but invisible in the water.

It is widely distributed over the tropical Atlantic, from the Canary Islands to Tortugas, Florida. The Plankton Expedition found it in abundance in the South Equatorial Stream. It is common upon the surface.

The position of the gonads distinguishes it from *R. velatum*, wherein these organs are upon the middle thirds of the radial-canals, whereas in *R. clavigerum* they are adjacent to the base of the stomach.

Genus SMINTHEA Gegenbaur, 1856.

Sminthea, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 245.—Metschnikoff, 1886, Arbeit. Zool. Inst. Wien, p. 244.
Trachynema, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 12.

The type species is *Sminthea eurygaster* Gegenbaur, 1856, of the Mediterranean and tropical Atlantic.

GENERIC CHARACTERS.

Trachymedusæ with only 8 tentacles, one at the foot of each of the 8 radial-canals. In other respects this genus is similar to *Rhopalonema*.

Sminthea eurygaster Gegenbaur.

Sminthea eurygaster, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 245, taf. 9, figs. 14-15.—Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien, p. 244.
Tholus eurygaster, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 365.
Trachynema eurygaster, Haeckel, 1879, Syst. der Medusen, p. 260.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 12.—Browne, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 171.
Marmanema mammæforme, Haeckel, 1879, Syst. der Medusen, p. 262.

This is a rare medusa. Bell 4.5 mm. wide and 2 mm. high. 8 radially placed tentacles and 8 interradial lithocysts. Velum about half as wide as bell-height. Manubrium only about one-fourth to one-half as long as depth of bell-cavity. 8 gonads, small, globular to egg-shaped,

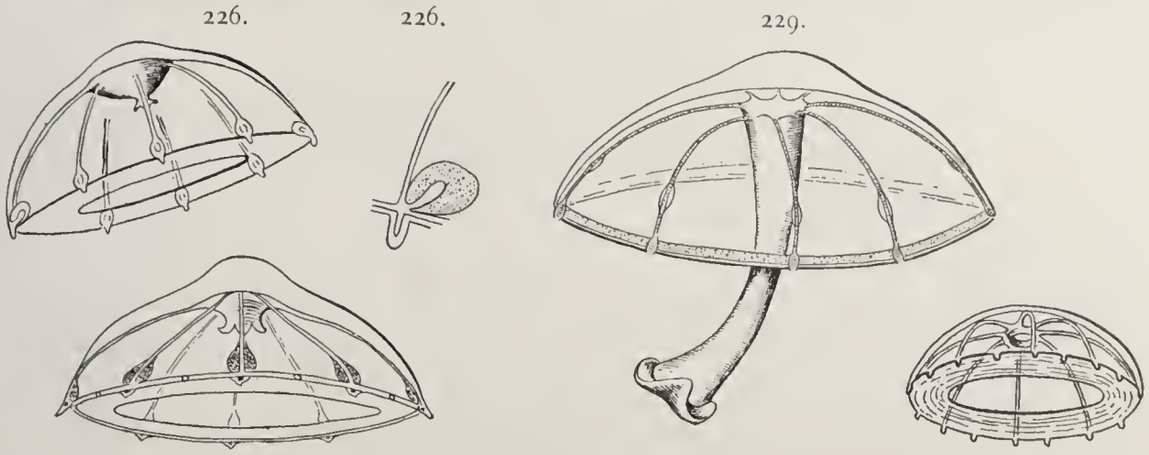


Fig. 226.—*Sminthea eurygaster*, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8. Side view of medusa and enlarged view of gonad.
Fig. 227.—"*Marmanema mammæforme*," after Haeckel, 1879.= *Sminthea eurygaster*.
Fig. 228.—"*Sminthea leptogaster*," after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.= *Rhopalonema velatum* (?)
Fig. 229.—"*Trachynema longiventris*," after Maas, in Ergeb. Plankton Expedition. Young stage of *H. typicum*?

project from the 8 radial-canals *very near the ring-canal*. Medusa with tentacle-bases faint red, gonads faintly yellow. Found in the Mediterranean and in warm parts of the Atlantic. It is distinguished by its protrusive, sac-like gonads, close to the bell-margin and by having but 8 tentacles when mature.

Genus HOMŒONEMA Maas, 1893, 1897.

Trachynema+Homœonema, Maas, 1893, Ergebnisse der Plankton Exped., Bd. 2, K. c., pp. 12, 15, 20.
Homœonema, Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 21, p. 22.
Colobonema+Homœonema, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Exped., Dampfer *Valdivia*, Bd. 3, Lfg. 1, pp. 56, 62.
Isonema (in part), Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, p. 4, Anvers.
Colobonema, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 132.

Maas founded this genus in 1893 for two medusæ, the first to be described being *Homœonema platygonon* of the north Atlantic.

GENERIC CHARACTERS.

Medusa similar to *Rhopalonema*, but the tentacles are all similar in structure each to each. 4 lips. 8 radial-canals with 8 localized gonads. No peduncle. Tentacles arising in a single row from the bell-margin.

In 1902 Vanhöffen established the genus *Colobonema* for a medusa which may have been described by Maas, 1897, under the name *Homœonema typicum*. Vanhöffen discovered that in this medusa the 8 tentacles which are midway between the 8 radial-canals are the last to develop. Thus the medusa may have 24 well-developed tentacles and 8 young (small) interradial tentacles, 32 in all. In other respects this medusa is similar to *Homœonema*, and indeed I regard it as a special case of *Homœonema* in which the interradial tentacles are the last to appear.

Bigelow, 1909, calls attention to the fact that no one has seen lithocysts in "*Colobonema sericeum*," but we must remember that these bodies are very readily lost in Trachymedusæ.

Bigelow, who studied a large number of specimens, decides that *Homœonema typicum* of Maas, 1897, is specifically distinct from "*Colobonema sericeum*" of Vanhöffen, 1902; but Maas, who has seen both forms, states that they are identical. I have placed "*Colobonema sericeum*" provisionally in the genus *Homœonema*, and incline, although doubtfully, to follow Maas in considering it as being synonymous with *Homœonema typicum*. Future studies may demonstrate that *Colobonema* should be separated generically for *Homœonema*, as has already been done by Bigelow, 1909.

In 1906, Maas institutes a genus *Isonema* with tentacles similar each to each and in a single row, and with gonads adjacent to the sides of the stomach. Maas proposes this genus for *Homœonema amplum*, Vanhöffen, 1902. I can not separate it from *Homœonema*.

Synoptic Table of the Species of Homœonema.

	Homœonema typicum Maas, 1897 = Colobonema sericeum Vanhöffen, 1902 = Colobonema typicum Maas, 1905.	Homœonema amplum Vanhöffen, 1902 = Isonema amplum Maas, 1906.	Homœonema macrogaster Vanhöffen, 1902.	Homœonema militare Maas, 1893.	Homœonema platygonon Maas, 1893; Browne, 1903.
Shape and size of bell in mm.	Dome-like, higher than a hemisphere. 45 wide, 35 high.	Flatter than a hemisphere, evenly rounded. 15 wide.	Evenly rounded. 7 wide.	Miter-shaped with well-developed projection 7 to 10 wide. 6 high.	Hemispherical, to higher, with a low, hollow, dome-like apex. 2 to 4 wide.
Number and character of tentacles.	32. All of same size. Flattened tangentially. 8 oldest, radial + 16 next oldest, adradial + 8 youngest, interradial.	88+, all of similar size and character.	84, all of same size and character.	50±. All about equally developed.	40 to 80, all similar.
Number and character of lithocysts.	? Not seen.	4 or none.	32. 4 in each octant. Definitely spaced between tentacles.	4 club-shaped.	4 vesicular, in middle of alternate interradii.
Length of manubrium in terms of depth of bell-cavity.	One-third to 1. Very variable in length.	Very small. −0.2.	Large. Exact size?	0.5±	0.25
Shape and position of gonads.	Spindle-shaped. On about 0.75 of length of radial-canals, leaving both ends free. Gonads begin to develop on outer parts of radial-canals.	8 spherical gonads upon radial-canals adjacent to stomach. 4 gonads are large, alternating with 4 small gonads.	8 spherical on 8 radial-canals adjacent to sides of stomach. Gonads all of same size.	8 wide lancet-shaped on outer halves of 8 wide radial-canals above ring-canal.	8 wide, flat, surrounding base of stomach and extending one-third to half-way out along 8 radial-canals.
Color.	Colorless, very iridescent, or iridescent light-brown?	Colorless.	Bell-margin dark-colored, other parts colorless.	?	Stomach, gonads, and canals opaque. Other parts transparent glassy.
Where found.	From depths of 115 to 1,500 fathoms. Tropical Atlantic and Pacific.	Bouvets Islands, South Atlantic near Antarctic circle.	Southern part of Indian Ocean from depth of 100 fathoms, S. lat. 30° 7′, E. long. 87° 50′.	Tropical Atlantic, Bermudas, Mediterranean.	North Atlantic, coast of Norway.
Distinctive characters.	32 tentacles, having very characteristic mode of development. Gonads on three-fourths length of radial-canals.	8 spherical gonads, 4 small alternating with 4 large. All close to sides of stomach. 4 lithocysts.	8 spherical gonads as in H. amplum, but all of similar size. 32 lithocysts.	50± tentacles all quite similar each to each. Very wide radial-canals. Club-like, lithocyst organs. Gonads on outer half of radial-canals.	50± tentacles all quite similar each to each. Radial-canals not very wide (Browne). Lithocysts vesicular. Gonads adjacent to sides of stomach.

Homœonema typicum Maas.

Homœonema typicum, Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 22, taf. 3, fign. 1–3.
(?) *Trachynema longiventris* (young medusa ?), Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 12, taf. 1, fig. 7.
Non Rhopalonema typicum, Agassiz, A., and Mayer, 1902, Mem. Mus. Comp. Zool. at Harvard College, vol. 26, p. 152, plate 5, figs. 21, 22.—Bigelow, 1904, Bull. Mus. Comp. Zool. Harvard College, vol. 39, p. 256.
Colobonema sericeum, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 57, taf. 9, fig. 1; taf. 12, fign. 39–42.—Browne, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 172.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 133, plate 2, figs. 4, 5; plate 45, fig. 12.
Colobonema typicum, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 53, taf. 10, fign. 62–65.

Bell higher than a hemisphere, thin but rigid walls, evenly rounded above. 45 mm. wide, 35 mm. high when full grown; 12 mm. high, 9 mm. wide when smaller. When mature there are 32 equally developed tentacles which are tangentially compressed with swollen basal bulbs, so as to remind one of narrow, ribbon-like lappets. When the medusa is young

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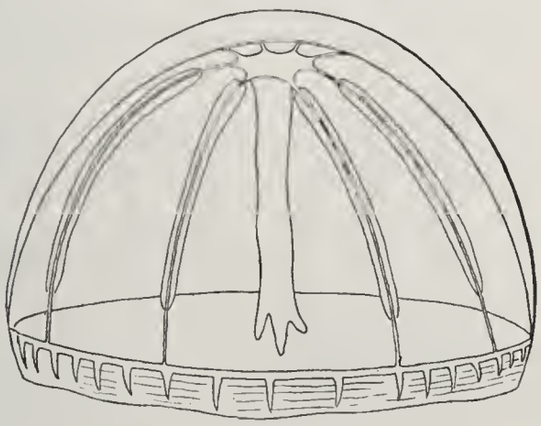

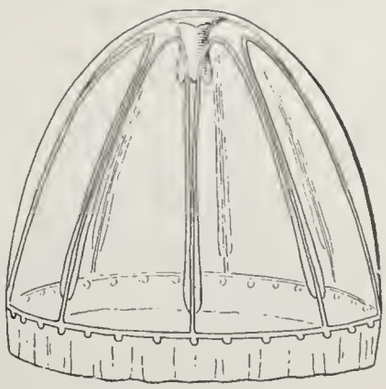

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Fig. 230.—*Homœonema* (*Colobonema*) *typicum*, after Maas, in Hydromedusen *Siboga* Expedition.
Fig. 231.—"*Colobonema*" *sericeum*, after Vanhöffen, in Tiefsee Expedition *Valdivia*.

there are only 8 tentacles, one at the base of each radial-canal. The next to develop are 8 adradial tentacles close by the sides of 4 alternate, radial tentacles. Then 8 more adradial tentacles appear by the sides of the remaining 4 radial tentacles. Then 4 interradial tentacles develop 90° apart, and finally 4 more interradial tentacles grow out in the remaining spaces. Thus the medusa goes through 5 stages as follows:

(1) 8 original, radially placed tentacles; (2) 8 radial + (2 x 4) 8 adradial tentacles = 16; (3) 8 radial + 8 adradial + (2 x 4) 8 adradial tentacles = 24; (4) 8 radial + 16 adradial + 4 interradial (90° apart) = 28; (5) 8 radial + 16 adradial + 4 interradial + 4 interradial = 32.

This peculiar order of development of the tentacles has been observed by both Vanhöffen, Bigelow, and Maas. Lithocysts (?)

The velum and the circular muscles of the subumbrella are well-developed. There are 8 short radial-canals and a narrow, simple ring-canal. The manubrium is one-third to three-fourths as long as bell-height and has 4 sharply-pointed lips. 8 narrow, spindle-shaped gonads, with blunt ends near the edge of the stomach and pointed ends near the circular canal. When young they are found on the outer two-thirds of the radial-canals, but usually extend toward the periphery of the stomach so as to cover about three-fourths of the radial-canals, leaving both ends free. Color brilliantly iridescent and transparent (Vanhöffen, Bigelow), but in the preserved medusæ studied by Maas the stomach, canals, and gonads were light-brown.

Maas appears to have first described this medusa from great depths off the Pacific coast of Central America and later from depths of 210 to 770 fathoms from the Malay Archipelago. Vanhöffen records it from the west coast of Africa from Sierra Leone southward to 42° S. lat. from depths of 115 to 1,500 fathoms.

Vanhöffen, 1902, presents beautiful figures of the medusa which agree with the description of Maas, excepting that the gonads are upon the outer two-thirds of the radial-canals and the stomach is shorter than the depth of the bell-cavity. These same conditions characterize the original "*Homœonema typicum*" described by Maas, 1897, from the Pacific coast of Central

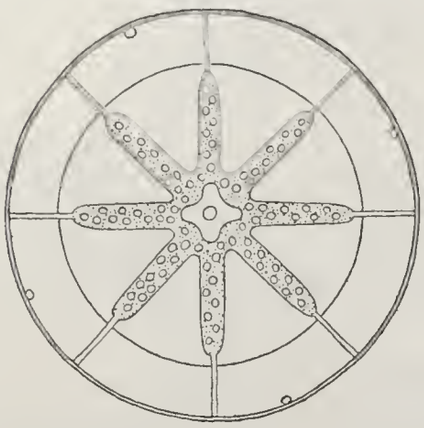
America. Probably the original specimens studied by Maas (1897) and those of Vanhöffen (1902) were not fully grown; those of the *Siboga* expedition described by Maas, 1905, being considerably larger. Bigelow, 1909, finds that the manubrium varies greatly in length.

Browne, 1906, records a small specimen from a depth of 250 fathoms to surface in the Bay of Biscay. Bigelow, 1909, records it from the eastern tropical Pacific and states that it belongs to the intermediate bathymetric fauna.

Homœonema platygonon Maas.

Homœonema platygonon, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 15, taf. 1, fig. 8.—Browne, 1903, Bergens Museums Aarbog, No. 4, p. 21, plate 2, figs. 2, 3; 1906, Trans. Linnean Soc. London, Zool., ser. 2, vol. 10, p. 174.

Bell somewhat higher than a hemisphere, with a low, small, dome-like apical projection and thin walls. Bell 2 to 4 mm. wide and about 2 mm. high. There are 40 to 80 closely crowded tentacles, all of similar appearance, but all were broken off short. There are 4 vesic-



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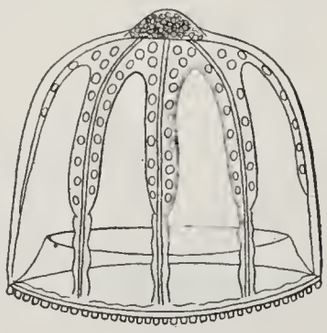

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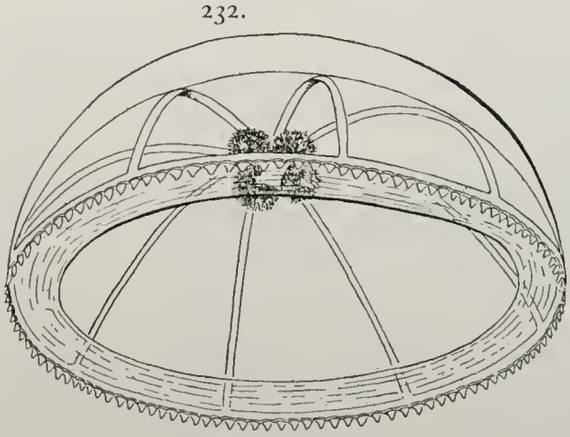

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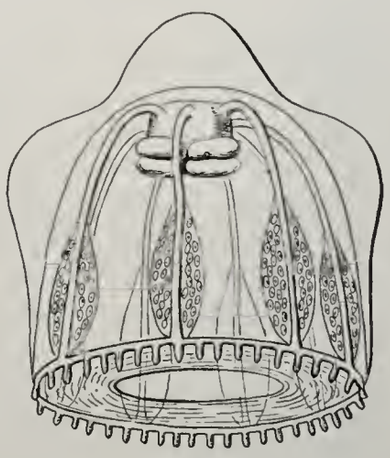

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Fig. 232.—*Homœonema platygonon*, after Browne, in Bergens Museums Aarbog, 1903.
Fig. 233.—*Homœonema platygonon*, after Browne, in Bergens Museums Aarbog.
Fig. 234—*Homœonema platygonon*, after Maas, in Ergeb. der Plankton Expedition.
Fig. 235.—*Homœonema militare*, after Maas, in Ergeb. der Plankton Expedition.
Fig. 236.—*Homœonema amplum*, after Vanhöffen, in deutsch. Tiefsee Expedition "*Valdivia*."

ular lithocysts, near the interradial points of 4 alternate octants. Bell-margin studded with nematocysts. Velum is about one-fourth as wide as bell-radius. There are 8 straight, fairly wide radial-canals and a simple ring-canal. Stomach very short, being only about one-fourth as long as depth of bell-cavity, and there are 4 short, simple lips. When fully expanded, however, the mouth becomes a round opening according to Browne, 1906.

The cavity at the base of the stomach extends up into the aboral dome-like apex of the bell. The gonads form a broad band around the base of the stomach and extend outward on both sides of each radial-canal for about one-third to one-half the length of the 8 canals.

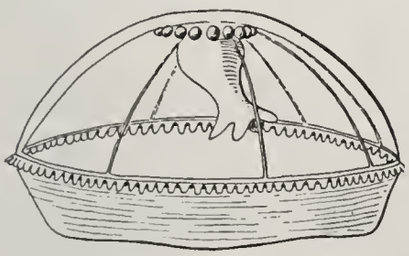
The gonads, stomach, and radial-canals are yellowish-white in preserved specimens, all other parts being colorless.

Browne describes this species from the coast of Norway, Skjerstadfjord and Byfjord. The Plankton expedition of 1889 found it somewhere in the Atlantic, according to Browne, between Iceland and Greenland, in lat. 60° N. According to Maas, 1906, this medusa is found in deep water in the subtropical Atlantic. Maas states that the Arctic *H. platygonon* is closely related to the Antarctic medusa called *Haliscera alba* by Vanhöffen. This conclusion he bases upon a recent study of Vanhöffen's own specimens. However, Vanhöffen states that his *Haliscera alba* has a bell 35 mm. wide, whereas *H. platygonon* is apparently only about 4 mm. wide, so that the two species are apparently distinct.

Homœonema militare Maas.

Homœonema militare, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 16, taf. 1, fig. 1; *Ibid.*, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 54.

Bell miter-shaped with a well-developed apical projection and bulging (contracted?) sides. 7 to 10 mm. wide, 6 mm. high. Velum over 2 mm. wide. A large number (about 50) of about equally developed tentacles. About 4 large, spherical lithocyst-clubs, each mounted upon a short, thin stalk. 8 wide radial-canals with 8 wide, lancet-shaped gonads upon their



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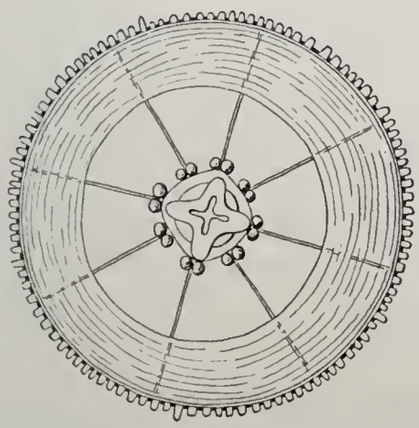

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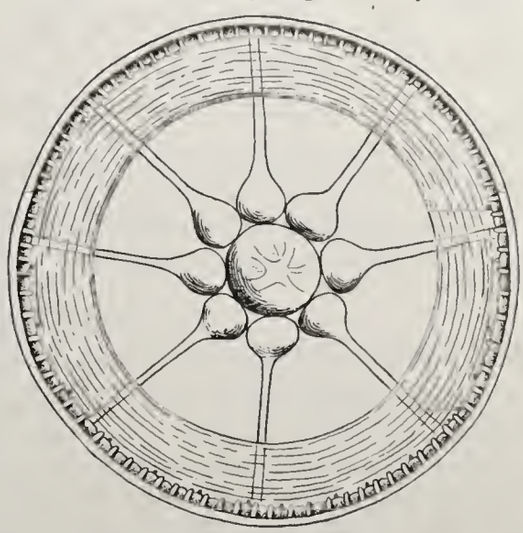

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Fig. 237.—"*Isonema*" *amplum*, after Maas, in Voyage *Belgica*. Side view above. Oral view below.

Fig. 238.—*Homœonema macrogaster*, after Vanhöffen, in *Valdivia* Tiefsee Expedition.

distal halves, above the ring-canal. Stomach large, 8-sided above, 4-sided below the middle. With 4 lips. When contracted the stomach is one-third to one-half as long as the depth of the bell-cavity. A single specimen found by Plankton Expedition north of the Bermudas in about N. lat. 38° from a depth of 400 fathoms. Later it was found in the Mediterranean by Lobianco. (See text-figure 235.)

Homœonema amplum Vanhöffen.

Homœonema amplum, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 65, taf. 10, fig. 21; taf. 11, fign. 24, 26, 27.

Isonema amplum, Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, Medusen, p. 5, taf. 1, fign. 1, 2, 7; taf. 2, fign. 8, 12; taf. 3, fign. 14, 20.

Bell 15 mm. wide, somewhat flatter than a hemisphere. Gelatinous substance quite thin, thicker at apex. About 100 or more tentacles, all similar each to each. 4 to 8 marginal lithocyst-clubs. 8 radial-canals. 8 spherical gonads upon the radial-canals adjacent to stomach; these sometimes differ in size, 4 being large. The stomach is very small, urn-shaped with

4 simple lips; unpigmented but iridescent. The 4 radial-canals are bordered with prominent entodermal supporting cells which give them a jagged-edged appearance. South Atlantic, near the Antarctic circle. Only three specimens were found by the *Valdivia*, but the *Belgica* found the medusa to be common in the Antarctic Ocean. (See text-figure 237.)

According to Mâas, the bell is higher than a hemisphere when young, but becomes flattened as growth proceeds. Medusæ 2 to 3 mm. wide have about 80 tentacles, but when the animal is 6 mm. wide there are 100 to 120 tentacles.

Homœonema macrogaster Vanhöffen.

Homœonema macrogaster, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 66, taf. 10, fig. 22.

Bell 7 mm. wide. 8 radial-canals. 84 tentacles, all of the same size and character. 32 lithocysts. Velum well developed. The 8 similar, spherical gonads are adjacent to the sides of the stomach. The diameter across the gonads and stomach is about one-third that of the bell itself. Stomach large, with 4 lips. Bell-margin dark-colored, other parts colorless. A single specimen was found by the *Valdivia* in the southern part of the Indian Ocean at a depth of 100 fathoms, S. lat. 30° 7′, E. long. 87° 50′. (See text-figure 238.)

Genus TETRORCHIS Bigelow, 1909.

Tetrorchis, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 123.

The type species is *Tetrorchis erythrogaster* Bigelow, from the eastern tropical Pacific.

GENERIC CHARACTERS.

Trachymedusæ with 8 radial-canals and only 4 gonads, attached to 4 of the radial-canals near their junction with the ring-canal. No peduncle. 4 lips.

Tetrorchis erythrogaster Bigelow.

Tetrorchis erythrogaster, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 124, plate 29, figs. 1–3.

Bell pyriform, 10 to 12 mm. wide, 8 mm. high. Gelatinous substance very thick apically, but thin at margin. 4 perradial tentacles of large size opposite the 4 fertile radial-canals. About 24 swollen tentacles not placed in reference to the radial-canals. Lithocysts (?) 8 straight, narrow radial-canals, only every alternate canal bearing a gonad. Gonads sausage-shaped and suspended near the bell-margin. Manubrium cylindrical, without a peduncle; as long as the depth of bell-cavity and with 4 small lips. Manubrium brilliant carmine, lips white, other parts colorless.

Eastern tropical Pacific, 300 fathoms to surface. 6 specimens found by the Albatross expedition of 1904–05.

Genus PANTACHOGON Maas, 1893.

Pantachogon, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K.c., p. 17; 1904, Résult. Camp. Prince de Monaco, fasc. 28, p. 29; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 55.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 62.—Monaco (Prince of), 1905, Compt. Rendus Acad. Sci. Paris, tome 140, p. 1374.

The type species is *Pantachogon haeckelii* Maas, from the deep water of the Atlantic.

GENERIC CHARACTERS.

Trachymedusæ with tentacles arising in a single row from the bell-margin. With gonads not localized, but developed diffusely along the entire lengths of the 8 radial-canals. With 4 lips. No peduncle.

It must be borne in mind that all of the descriptions of the medusæ called *Pantachogon* are based upon the study of preserved specimens. It is possible, therefore, that the "diffusely developed gonads" are only the contracted and opaque edges of the entodermal, supporting lamella along the sides of the radial-canals.

Pantachogon haeckelii Maas.

Pantachogon haeckelii, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K.c., p. 17, taf. 1, fig. 2; 1904, Résult. Camp. Sci Prince de Monaco, fasc. 28, p. 29.

Bell half-egg-shaped with thin walls and without apical projection; 8 to 12 mm. high, 6 to 10 mm. wide. Velum large, 2.5 to 3 mm. wide. About 64 well-developed tentacles. Numerous nettling warts upon bell-margin. Lithocysts (?) Stomach with an 8-sided base and 4 lips. 8 narrow, straight radial-canals. The 8 gonads are developed as irregularly placed, narrow, spindle-shaped bodies on both sides of the radial-canals, from stomach to bell-margin. One specimen found by the Plankton expedition at a depth of 300 fathoms, in N. lat. 60°, southwest of Iceland, in July, 1889. Another found by the Prince of Monaco at Spitzbergen, in 1899.

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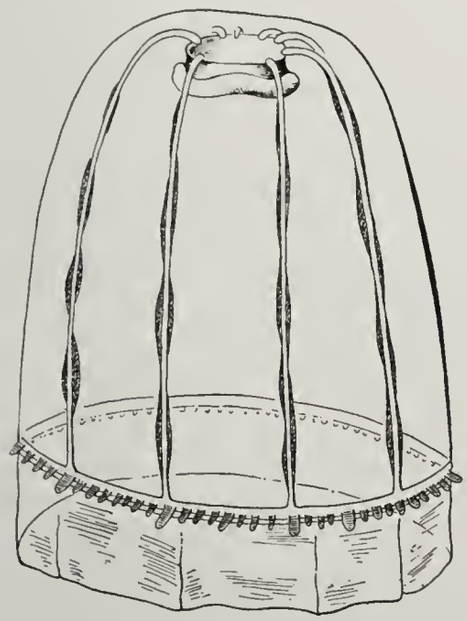

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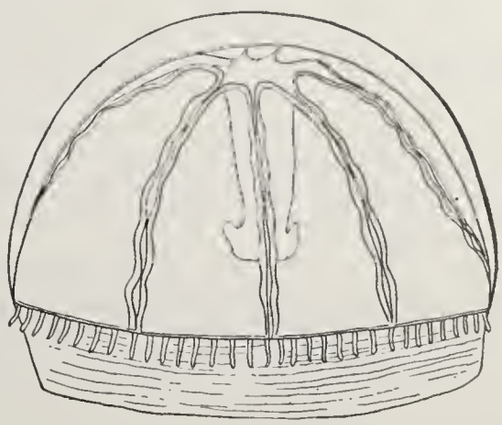


Fig. 239.—*Pantachogon haeckelii*, after Maas, in Ergeb. Plankton Exped.

Fig. 240.—*Pantachogon rubrum*, after Maas, in Hydromedusen, *Siboga* Expedition.

Unfortunately, the color is unknown and it is possible that this Arctic species may prove to be identical with the deep-water *P. rubrum* of the tropical Atlantic and Pacific. *P. haeckelii* appears to become mature when smaller than *P. rubrum*, but much allowance for variation must be made when comparing preserved specimens one with another, especially where the examples are few, as in this case.

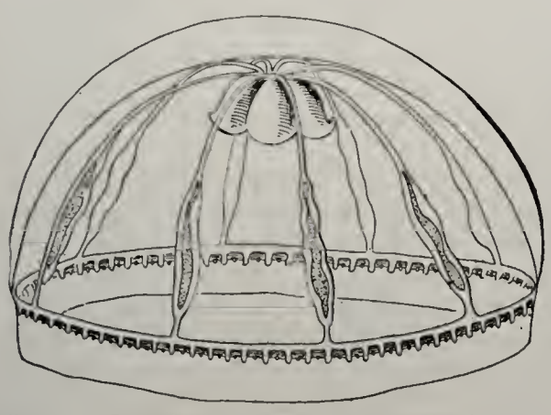


Fig. 241.—*Pantachogon rubrum*, after Vanhöffen, in Tiefsee Expedition *Valdivia*.

Pantachogon rubrum Vanhöffen.

Pantachogon rubrum, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 63, taf. 9, fig. 9; taf. 10, fign. 19, 20; taf. 11, fig. 25.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 55, taf. 10, fig. 66.

(?) *Pantachogen haeckelii*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K.c., p. 17, taf. 1, fig. 2.

According to Vanhöffen the bell is 13 mm. high, 10 mm. wide; according to Maas, 6 to 12 mm. high and 9 to 15 mm. wide. These discrepancies are doubtless due to degrees of contraction in the preserved specimens. Bell dome-shaped with thin walls and evenly-rounded apex.

There are 64 tentacles which are quite similar each to each and lack swollen, basal bulbs, such as are seen in *Homœonema (Colobonema) typicum*, but are of uniform width throughout. The complete tentacles have never been seen, however, for they were broken off quite close

to their insertions in all specimens which have been studied. 64 lithocysts alternate with the 64 tentacles. Velum very large and powerful, being 3 mm. wide in a medusa 14 mm. in diameter. 8 straight, narrow radial-canals and a simple circular vessel. Manubrium octagonal at base, 4-sided below, the mouth having 4 simple, recurved lips is two-thirds to three-fourths as long as the bell-height and lacks a peduncle. The gonads are said to be irregularly and diffusely developed along the entire subumbrella edges of the 8 radial-canals. They begin to develop when the medusa is about 12 mm. wide, and 9 mm. high (Maas, 1905, p. 56).

In mature medusæ the entoderm of the stomach and subumbrella lamella are of a beautiful red color and the velum is white. In young medusæ the stomach alone is red.

Found at depths of 1,000 fathoms to surface in the tropical parts of the Atlantic, Indian, and Pacific oceans.

Vanhöffen, 1902, presents beautiful figures of this medusa, and Maas, 1905, gives a table of measurements, together with a good figure.

This may prove to be identical with *P. haeckelii* of the Arctic Ocean. Its only distinctive character appears to be its bright red color, but the color of *P. haeckelii* is unknown.

Genus HALICREAS Fewkes, 1882.

Halicreas, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College vol. 9, No. 8, p. 306.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 56; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 493, Jena.—Browne, 1908, Trans. Roy. Soc. Edinburgh, vol. 46, p. 237.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 138.
Halicreas+*Haliscera*, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Exped., Dampfer *Valdivia*, Bd. 3, Lfg. 1, pp. 67, 68.
Halicreas, *Haliscera*, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 21.
Isonema (in part), Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, Medusen, p. 4, Anvers.
Homœonema (in part), Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 141.

GENERIC CHARACTERS.

Trachymedusæ with a simple, conical stomach and *round* mouth-opening, without 4 lips. No peduncle, 8 wide radial-canals upon which the 8 gonads are developed. Numerous tentacles of various sizes arising in a single row from the bell-margin. Lithocyst-clubs between the tentacles. No suckers upon the tentacles. Ring-canal simple, without centripetal diverticula.

This genus is distinguished from *Rhopalonema* and *Homœonema* by its simple, round mouth-opening without cruciform lips. Bigelow's, 1909, clear photographs show this round mouth-opening. He also observed the tentacles in living medusæ and finds that they are arranged in a single, linear series and that each tentacle consists of a soft, flexible proximal, and a stiff spine-like distal region. This remarkable condition is most characteristic of this genus and serves at once to distinguish it.

8 radially placed clusters of wart-like projections are often seen upon the sides of the exumbrella above the margin, but these are not present in all species and are, according to Vanhöffen and Maas, very variable in their development in any given species. A solid apical projection may or may not be present and, according to Maas, 1905, its presence or absence is not even of specific importance. Some specimens of *H. papillosum* have it well developed, while from others it is absent. The 8 radial-canals are very broad, ribbon-like, and flat in all known species.

The oldest species is *Halicreas minimum* Fewkes, of the Gulf Stream off the Atlantic coast of America, but this is described from such imperfect specimens that it will be impossible to determine it with certainty. It is probably identical with *H. papillosum*, Vanhöffen, 1902, from the tropical Atlantic, Indian, and Pacific Oceans. The latter may, therefore, serve as the type of the genus, for it will never be possible to determine Fewkes's specimens specifically.

Vanhöffen studied an extensive series of specimens found by the *Valdivia* off the African coast in the Atlantic and Indian Oceans. He separates them into two genera, retaining *Halicreas* Fewkes, but instituting a new genus, "*Heliscera*," for medusæ resembling *Halicreas* but with wider radial-canals, fewer tentacles, different color and a wider, more open mouth, with a cylindrical, not conical, stomach. These distinctions are merely relative, and in my system such intergrading characters are regarded as of specific, not of generic, value. Great confusion invariably follows upon attempts to separate genera upon the extremes of intergrading

characters, for specimens displaying such characters in intermediate degrees must either be placed in a third "genus" or confusedly classed either with one or the other, sometimes being considered to belong to one and again to the other genus. It is well known that in Haeckel's system certain medusæ, by merely contracting or extending the manubrium, may change from one "genus" to another, while his Siphonophoræ invariably break up into new "genera" and "species" when the sexual generation is set free.

Vanhöffen distinguishes five species of *Halicreas*+"*Haliscera*," the specific distinctions being based on form of bell, width of radial-canals, position of gonads, and color. Maas, 1905–06, shows that the form of the bell is very variable in *H. papillosum*, and he believes that certain of Vanhöffen's species should be reduced.

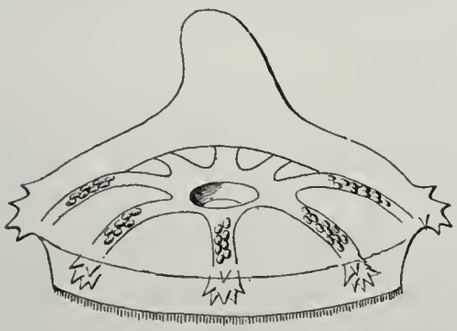
Halicreas resembles the Trachymedusæ in its marginal tentacles and 8 simple radial-canals with a marginal ring-canal. It recalls the Narcomedusæ, however, in its conical-cylindrical stomach with its wide, round mouth-opening.

Maas made a restudy of the *Valdivia* specimens and has concluded that the Antarctic *Haliscera alba* Vanhöffen belongs to the genus *Homœonema* Maas and is closely related to the Arctic medusa *Homœonema platygonon* Maas. Maas does not redescribe the medusa and his grounds for this opinion are not wholly clear. I have, therefore, retained *H. alba* provisionally in the genus *Halicreas*. "*Isonema*" *racovitzæ*, described from a single preserved specimen by Maas, appears to have all of the characters of *Halicreas*. As the generic name *Halicreas* takes precedence, I do not think we can follow Bigelow, 1909, in calling this genus *Homœonema*.

Halicreas papillosum Vanhöffen.

(?) *Halicreas minimum*, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, No. 8, p. 306.

Halicreas papillosum, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 68, taf. 9, fign. 7, 8; taf. 11, fig. 30.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 57, taf. 10, fig. 70; taf. 11, fig. 71.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 138, plates 3, 33, 34.



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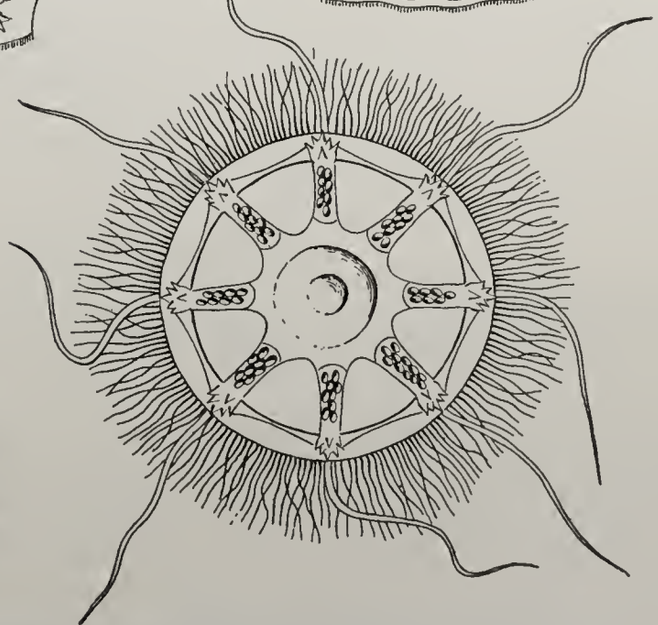

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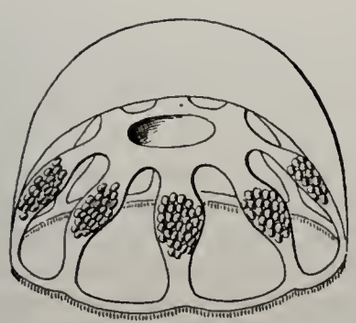

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Fig. 242.—*Halicreas papillosum.* Fig. 244.—*Halicreas* (*Haliscera*) *rotundatum.*
Fig. 243.—*Halicreas papillosum.* Fig. 245.—*Halicreas glabrum.*
Above figures after Vanhöffen, in Tiefsee Expedition *Valdivia.*

Bell 44 mm. wide, flat and thick-walled. A solid apical projection is usually, but not invariably present. 8 radially situated clusters of wart-like projections on sides of exumbrella in a zone above bell-margin. These wart-like, or prickle-shaped, projections are bluntly pointed and give the bell an octangular appearance when viewed from the apex or the oral side. They are quite variable in development and increase in size with age. Velum very wide. 130 to 640 tentacles of various sizes, the longest and widest being at the bases of the 8 radial-canals, while the interradial, adradial, etc., are of decreasing size and are apparently younger; the tentacles taper gradually and the longest are about as long as the bell-diameter; while the smallest tentacles in mature medusæ are about two-thirds as long as the bell-radius. Bigelow, 1909, finds that the tentacles consist of a flexible part extending out from the bell-margin, and a stiff rod-like, outer, terminal portion, resembling a bristle in appearance. The tentacles are solid, their entoderm being composed of a row of chordate cells with cubical cells in the flexible and flat tile-like cells in the stiff part of the tentacle. There are 3 to 4 elongate lithocyst-clubs per octant, each probably containing 1 to 2 concretions. There are 8 wide, ribbon-shaped radial-canals and a wide ring-canal. The stomach is short and conical and the mouth is a wide circular opening. The 8 gonads are elongate and elliptical and are developed upon nearly the entire lengths of the 8 radial-canals.

The entoderm of the stomach and canals ranges from being colorless to bright red.

The *Valdivia* expedition found this species at depths of 300 to 2,000 fathoms in the tropical Atlantic and Indian Oceans off the African coast. It is probably identical with the medusa described by Fewkes from the Gulf Stream off the coast of New England, United States. The *Siboga* expedition found it among the islands of the Malay Archipelago and Bigelow found it to be common in the eastern tropical Pacific.

Fewkes states that the gonads are sausage-shaped in his *H. minimum*, but his specimens were so badly damaged that it will be impossible to determine whether they should be considered identical with *H. papillosum*, for the radial-canals, stomach, and tentacles were absent.

Halicreas rotundatum Vanhöffen.

(?) *Halicreas glabrum*+*H. rotundatum*, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Exped., *Valdivia*, Bd. 3, Lfg. 1, pp. 70, 71.

Halicreas rotundatum, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 71, taf. 9, fig. 4.—MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 57.

Bell rounded without an apical projection, 27 mm. wide. No prickle-shaped papillæ on exumbrella. 8 wide, short, egg-shaped gonads in middle of the 8 radial-canals. 8 long, radial and about 160 short, interradial tentacles. Mouth a wide, round opening. Color of all entodermal parts red, other parts colorless. Tropical parts of Atlantic and Indian Oceans, off the African coast. Lithocysts (?) May this not be a variety of *H. papillosum*? Maas, 1905, finds that the shape of the bell in *H. papillosum*, from the Malay Archipelago, is very variable. Is it identical with *H. glabrum*? (See text-figure 244.)

Halicreas glabrum Vanhöffen.

(?) *Halicreas glabrum*+*H. rotundatum*, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, pp. 70, 71.

Halicreas glabrum=*H. rotundatum* (?), MAAS, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 493, Jena.

Halicreas glabrum, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 70, taf. 9, fig. 3.

Bell 16 mm. high, with a blunt apical projection, and about 16 mm. wide. Higher than *H. papillosum*. Exumbrella smooth, without wart-like papillæ. 8 wide gonads on middle halves of the 8 radial-canals. There are about 30 short, slender tentacles between each successive pair of long, radial tentacles. Thus there are 8 long radial and about 240 short tentacles. Mouth a wide, round opening at extremity of a short, conical neck. Color of entoderm red; other parts colorless. Tropical parts of the Atlantic and Indian Oceans, off the African coast. Lithocysts (?) (See text-figure 245.)

Possibly a variety of *H. papillosum*? but more probably identical with *H. rotundatum*.

Halicreas racovitzæ.

Homœonema racovitzæ, Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 520.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 144.
Homœonema (Haliscera) racovitzæ, Maas, 1906, Expéd. Antarctique, S. Y. *Belgica*, Medusen, p. 10, taf. 1, fign. 3, 4; taf. 2, fig. 13.

Bell nearly hemispherical, being about 8 mm. wide and 3.5 mm. high; with moderately thick, gelatinous walls. 48 large tentacles, most of which were broken off short in Maas's specimens, but were complete in Bigelow's and resemble those of *H. papillosum*; these are somewhat irregularly arranged, but all of the same size and of similar structure. There are about 8 lithocyst-clubs, irregularly spaced, some octants being without them and others having 2 clubs which arise from the bell-margin between the tentacles. Velum very wide, being

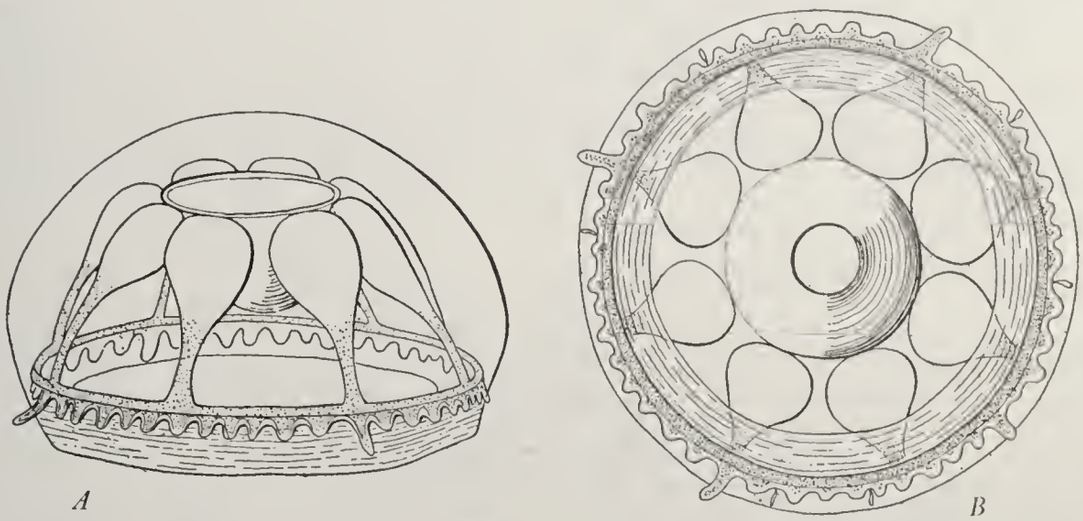


Fig. 246.—"*Homœonema racovitzæ*," after Maas, in Voyage S. Y. *Belgica*. *A*, side view; *B*, oral view.

1 mm. broad in medusæ 8 mm. in diameter. 8 wide, flat radial-canals and a wide, simple ring-canal. The stomach is a truncated cone with round mouth-opening; 3 mm. wide at base and 1 mm. wide at mouth. 8 flat, shield-shaped gonads, one upon each of the 8 radial-canals and extending from edge of stomach over nearly half the lengths of the canals. These gonads are similar in general appearance to those of Geryonidæ. The gonads are purple-violet and the entoderm reddish. Bell colorless, its musculature iridescent in preserved specimens.

Maas found one specimen in Antarctic Ocean lat. 70° 9′ S.; long. 82° 35′ W. Bigelow records two from off the coast of Peru.

Halicreas alba.

Haliscera alba, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Exped., Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 71, taf. 9, fig. 5.
Homœonema alba, Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, pp. 493, 520.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 142, plates 3, 33, 34.

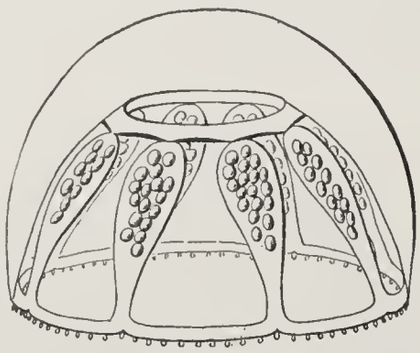
Bell dome-like, evenly rounded and nearly hemispherical, without an apical projection. Gelatinous substance quite thick at aboral pole, but thin at margin. Bell 35 mm. wide. There are 64 to 100 similar tentacles. Bigelow finds that the tentacles are similar to those of *H. papillosum*, having a flexible, proximal part and a stiff spine-like outer end. There are about 3 elongated sensory-clubs in each octant. Stomach very short and wide, and the mouth is represented by Vanhöffen and Bigelow as a wide, round opening. The stomach is between one-third and one-half as wide as the bell itself, and its side-walls are short and conical. There are 8 wide radial-canals, each with a lancet-shaped gonad extending from edge of stomach along two-thirds of length of canal. Each gonad contains 15 to 20 large, spherical eggs, quite widely separated one from another. The medusa is nearly colorless, the entodermal parts being sometimes more or less orange.

A single specimen was found southwest of Cape of Good Hope, Africa, in lat. 42° 18′ S., long. 14° 1′ E., in a vertical net dragged from a depth of 100 fathoms by the *Valdivia*.

Bigelow, 1909, records the capture of 9 specimens in the eastern tropical Pacific by the *Albatross*, between 300 fathoms and the surface, and his description of the medusa is the best yet published. His photographs show a simple, round mouth-opening such as is found in *Halicreas*, not four lips as are seen in *Homœonema*.

Maas maintains that this species belongs to his genus *Homœonema*, but he does not redescribe the medusa and does not state that 4 lips are present. Vanhöffen's beautiful figure shows a round mouth-opening and this would oblige us to place the medusa in the genus *Halicreas*. It is very much larger than "*Homœonema*" *platygonon* of Maas, being about 35 mm.

247.



248.

FIG. 247.—*Halicreas* (*Haliscera*) *alba.* FIG. 248.—*Halicreas* (*Haliscera*) *conica.*
Above figures after Vanhöffen, in Tiefsee Expedition, *Valdivia.*

wide instead of about 4 mm. as in *H. platygonon*; and while future studies may show that the widely distributed *H. alba* is identical with the Arctic "*Homœonema*" *platygonon*, the published evidence now available does not appear to me to warrant such a conclusion.

Halicreas conica.

Haliscera conica, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 72, taf. 9, fig. 6; taf. 11, fig. 33.—MAAS, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 493.

Bell 18 mm. wide, flatter than a hemisphere, with an apical projection. 8 oval gonads in middle of the 8 broad radial-canals. 72 tentacles, of uniform size. 16 lithocysts (?), 2 in each octant. Velum well developed. Colorless. Indian Ocean, depth of 500 to 1,000 fathoms. Beautifully figured in Vanhöffen's report on the veiled medusæ of the German *Valdivia* expedition.

Genus HALITREPHES Bigelow, 1909.

Halitrephes, BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 145.

The type species is *Halitrephes maasi* Bigelow, of the eastern tropical Pacific.

GENERIC CHARACTERS.

Similar to *Halicreas*, but with more than 8 radial-canals.

Halitrephes maasi Bigelow.

Halitrephes maasi, BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 146, plates 33, 45.

Bell 55 mm. wide. Exumbrella smooth, low, rounded and without exumbral papillæ. Gelatinous substance thin and brittle. About 70 tentacles of various sizes. All with thick, flexible, proximal parts and relatively stiff, narrow, straight, outer halves, covered thickly with nematocysts as in *Halicreas*. A few lithocyst-clubs on the bell-margin between the tentacles. Central stomach 15 mm. wide, mouth-opening round. 28 broad radial-canals arise from stomach and 5 fork dichotomously so that 33 canals extend to the circular vessel. Gonads small, flat, and circular and close to the periphery of the stomach. Medusa colorless. Described by Bigelow from the *Albatross* collection of 1904–05. 3 specimens found off the coast of Peru, between 300 fathoms and the surface.

Genus BOTRYNEMA Browne, 1908.

Botrynema, Browne, 1908, Trans. Royal Soc. Edinburgh, vol. 46, p. 239.

The type species is *Botrynema brucei* of the Antarctic Ocean.

GENERIC CHARACTERS.

Similar to *Halicreas*, but the tentacles are grouped in clusters. The tentacles of each cluster arise in a single linear row around the margin. The margin is cleft into 16 shallow lobes.

Botrynema brucei Browne.

Botrynema brucei, Browne, 1908, Trans. Royal Soc. Edinburgh, vol. 46, p. 239, plate 1, figs. 8-9; plate 2, fig. 1.

Bell miter-shaped, thick-walled, and about as high as wide; with a conical projection at the aboral pole. Velum very broad. 8 perradial isolated tentacles and 16 groups of tentacles. The 8 perradial tentacles are longer than the others and project from the sides of the bell at a greater distance above the margin. Each arises from a deep groove, about 2 mm. above the margin of the bell. These large tentacles are probably directed upward or outward, while those of the groups are directed downward.

The bell-margin is cleft by 16 shallow grooves (8 perradial and 8 interradial) on to 16 shallow, adradial lobes. The 8 perradial grooves bear each a large tentacle but the interradial furrows lack tentacles. Each of the 16 adradial lobes bears a linear row of about 12

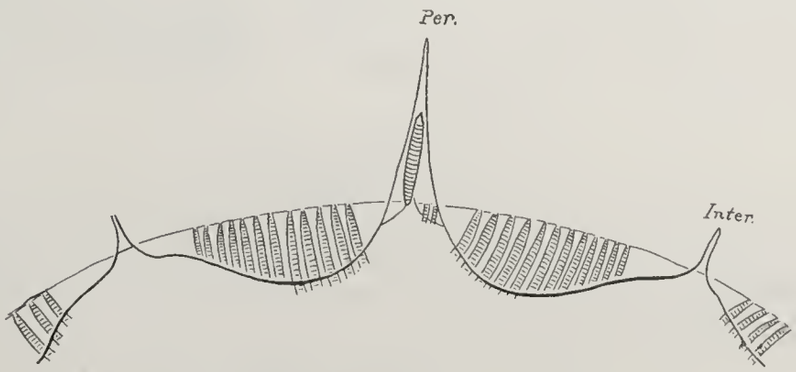


FIG. 248A.—Octant of bell-margin of *Botrynema brucei* showing arrangement of tentacles. After Browne, in Trans. Royal Soc. Edinburgh.

Per, perradial cleft. *Inter*, interradial cleft.

small tentacles of various sizes, the largest being nearest the radial-canals. In addition to these there may be a few minute tentacles between the adradial clusters and the perradial tentacles. No marginal sense-organs were observed. The stomach is 9 mm. wide, with a central gelatinous plug. Mouth circular. 8 broad, flat radial-canals and a wide circular vessel. 8 gonads, triangular with apices outward, on the central parts of the radial-canals. Color whitish. Lat. 64° 48′ S., long. 44° 26′ W., near Cape Horn, South America, in a trawl made between the surface and 2,485 fathoms, March 13, 1903.

Genus CROSSOTA Vanhöffen, 1902.

Crossota, VANHÖFFEN, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 72.—MAAS, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 492.—BIGELOW, 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 134.

The type species is *C. brunnea* of the South Atlantic and Indian Oceans.

GENERIC CHARACTERS.

Trachymedusæ with 8 radial-canals, 8 gonads on the radial-canals. Tentacles arise in several rows, from the margin of the bell. Mouth with 4 lips, stomach 8-sided. Lithocysts (?)

This genus bears some resemblance to *Ptychogastria*, but there are no mesenteries spanning between the stomach and the subumbrella, and the tentacles are not grouped into clusters, but arise at about equal intervals from the thickened bell-margin. I have therefore placed this genus in close proximity to *Botrynema*, *Halicreas*, and *Homœonema*.

Crossota brunnea, probably the only known species for the so-called *Crossota "norvegica"* Vanhöffen, is apparently only a synonym.

Crossota brunnea Vanhöffen.

Crossota brunnea, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 73, taf. 9, fign. 11–13; taf. 12, fign. 34–38, 43–47.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 135, plates 2, 45.

Bell dome-shaped, rounded, 32 mm. wide, 22 mm. high. Gelatinous substance fairly thin, thickest at aboral pole of bell. 6 rows of small, solid tentacles arise from the bell-margin, the entodermal, chordate roots of all of the tentacles arising from the radial-canal. The younger tentacles arise between the older ones and at a lower level. There are thus 6 rows,

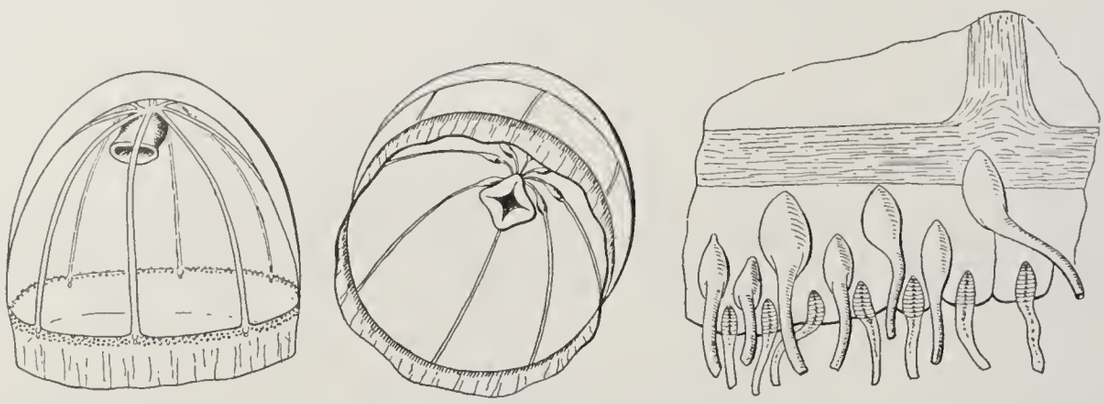


Fig. 249.—*Crossota brunnea*, after Vanhöffen, in deutsch. Tiefsee Expedition *Valdivia*. Showing insertions of tentacles at various levels above bell-margin.

consisting of 84 tentacles, in each octant. 8 narrow, straight radial-canals. 8 sausage-shaped gonads on the radial-canals near the stomach. Stomach small, 8-sided, with 4 lips. No peduncle. Entodermal lamella and all entodermal parts are rich reddish-brown. Atlantic, Pacific, and Indian Oceans; between the equator and 60° S. lat. at intermediate depths down to 3,200 fathoms. Lithocyst-clubs (?)

Crossota "norvegica" Vanhöffen.

Crossota norvegica, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 75.

Said to be characterized by its cherry-red color, instead of brown as in *C. brunnea*. Also, the gonads in *C. norvegica* are more developed in small medusæ than in specimens of *C. brunnea* of the same size. Off the coast of Norway, at a depth of 500 fathoms. Briefly mentioned by Vanhöffen, to whom Dr. Hjost showed two specimens from lat. 69° 13′ N., long. 10° 40′ E. As Bigelow states, this medusa is probably identical with *Crossota brunnea*.

Subfamily AGLAURINÆ.

Circeadæ (in part), Forbes, 1848, British Naked-eyed Medusæ, p. 34.
Aglauridæ, Haeckel, 1879, Syst. der Medusen, p. 268.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 57; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 494, Jena; 1893, Ergeb. Plankton Exped., Bd. 2, K. c., p. 26.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, part 3, p. 739.

SUBFAMILY CHARACTERS.

Trachymedusæ in which the stomach is mounted upon a gelatinous peduncle. With 8 radial-canals upon which the linear or sac-like gonads are developed. Numerous similar tentacles and free sensory-clubs.

The development of *Aglaura* is direct, without a fixed hydroid-stage, the actinula larva being transformed directly into the medusa. The tentacles of the actinula become those of the medusa and the bell is a secondary formation growing out in a collar-like expansion from the sides of the body and carrying the tentacles outward. The lithocyst-clubs develop before the bell and are evidently modified tentacles, the concretions being of entodermal formation. The bell of *Aglaura* appears, therefore, to be not homologous with the bell of Anthomedusæ and Leptomedusæ, for in these orders the bell forms *before* the tentacles and all of the tentacles arise later from its margin, whereas in *Aglaura* many of the tentacles precede the bell and are

pushed outward by its growth so as to appear at its margin in the developed medusa. The entodermal lithocyst-clubs are evidently not homologous with the ectodermal, vesicular lithocyst-sacs of Leptomedusæ. In common with other Trachymedusæ the Aglaurinæ may be regarded as *medusiform actinulæ*.

The gonads may be developed upon some or upon all of the radial-canals and they may be linear or sausage-shaped and suspended. In the genus *Amphogona* the medusa may be hermaphroditic, 4 of the gonads being male and the 4 on every alternate canal being female. In all other genera the sexes are separate.

The 8 radial-canals of the Aglaurinæ are perradial and interradial, not adradial in reference to the lips, as is claimed to be the case by Haeckel, 1879.

The Aglaurinæ, owing to their direct development and independence of coasts, are widely distributed over the world and are among the most characteristic Trachylina medusæ of the open ocean far from land. The genus *Aglantha* is characteristic of cold waters, while *Aglaura* is abundant in warm seas. A synopsis of the genera of the Aglaurinæ follows:

Gonads localized on some or all of the 8 radial-canals. Stomach mounted on a peduncle. Tentacles numerous and all alike.

Aglaura Péron and Lesueur, 1809. With 8 gonads upon the 8 radial-canals, on the peduncle. Sexes are separate. Development direct.

Aglantha Haeckel, 1879=*Aglantha*+*Agliscra* Haeckel. 8 gonads upon the subumbrella near the peduncle or upon the turning-points of the 8 radial-canals between the peduncle and the subumbrella. Sexes separate.

Amphogona Browne, 1904. Similar to *Aglantha*, but the 8 gonads are on the 8 radial-canals near the bell-margin.

Stauraglaura Haeckel, 1879. With 4 gonads upon every alternate one of the 8 radial-canals, the 4 other canals being sterile.

Persa McCrady, 1857. With 2 gonads on 2 of the radial-canals 180° apart. The 6 other radial-canals are sterile.

Genus AGLAURA Péron and Lesueur, 1809.

Aglaura, Péron et Lesueur, 1809, Annal. Mus. Hist. Nat. Paris, tome 14, p. 351.
Lessonia, Eydoux et Souleyet, 1841, Voyage de la *Bonite*, tome 2, p. 643.
Aglaura, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 248.—Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 10.—Haeckel, 1879, Syst. der Medusen, p. 274.—Maas, 1893, Ergeb. Plankton Exped., Bd. 2, K. c., p. 25; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 58.—Vanhöffen, 1902, Wissen. Ergeb. Tiefsee Exped., *Valdivia*, Bd. 3, Lfg. 1, p. 77.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, p. 739.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 117.

The following table will illustrate the differences between the several varieties of *Aglaura hemistoma*.

Synopsis of the Described Varieties of Aglaura hemistoma.

	A. "nausicaa" Haeckel.	A. "prismatica" Maas.	A. hemistoma Péron and Lesueur.	A. "radiata" Haeckel.	A. "laterna."	A. "octagona" Bigelow.
Size in mm.	2 to 3 wide, 4 high.	3 to 4 wide, 3 to 4 high.	3 to 4 wide, 4 to 6 high.	4 wide, 8 high.	6 wide, 8 high.	1.5 wide, 3 high.
Shape of bell.	Egg-shaped, oval.	Cubical to prismatic, with low apex.	Cylindrical or prismatic with relatively flat top.	Cylindrical or prismatic with 32 "ribs" (= bucklings of exumbrella due to contraction).	Octagonal prismatic below with pyramidal truncated top.	Octagonal pyramidal above with truncated top. Sides vertical.
Length of peduncle in terms of bell-radius (*r*).	Very short, 0.1 *r*.	Short, 0.5 *r*.	Short, *r*.	Fairly long, *r*±.	Long, 1.5 *r*.	Long, 1.5 *r*+.
Color of stomach.	Colorless.	Delicate rose, orange-brown or brownish-red.	Reddish-yellow to brownish-yellow.	(?)	Purplish-red.	Colorless.
Shape of gonads.	Club-shaped, widest at outer ends.	Sac-shaped to sausage-shaped.	Egg-shaped to sausage-shaped.	Club-shaped as in A. nausicaa.	Spherical or oval.	Egg-shaped.
Number of tentacles.	16 to 32	50 to 60	50 to 60	32	16 to 32	32
Where found.	Adriatic Sea, March.	Gulf of Panama to tropical Pacific (Fiji, Maldive).	Mediterranean, Atlantic, Pacific, Indian Oceans.	South Pacific. (Is this not a contracted A. prismatica?)	Canary Islands, in January.	Kolumandulu Atoll, Maldive Islands, Indian Ocean, December.

The type species is the very abundant *Aglaura hemistoma* Péron and Lesueur, found in all warm oceans. There are many closely related "varieties," the extremes being *A. nausicaa*, with a very short peduncle and *A. laterna* or *A. octagona* with long, tapering, slender peduncle. The typical *A. hemistoma* is an intermediate form. I wholly agree with Vanhöffen, 1902, in the belief that there is but one species and that this should be called *A. hemistoma*, for the peduncle is provided with longitudinal muscles and may be twisted from side to side, and to a limited extent contracted or elongated. Moreover, the bell may become "lantern-shaped," "8-sided," "egg-shaped," "narrow," or "wide" dependent upon its state of contraction. Bigelow, 1909, concurs in the opinion that *A. hemistoma* is the only known species.

GENERIC CHARACTERS.

Aglaurinæ with 8 gonads upon the peduncle, not upon the subumbrella.

The development of *Aglaura hemistoma* has been studied by Metschnikoff, 1886. It is direct, the actinula-like larva being transformed into the medusa; the tentacles of the medusa being those of the actinula and making their appearance before the bell begins to develop.

Aglaura hemistoma Péron and Lesueur.

Plate 46, figs. 4 and 5; plate 49, figs. 3 to 7; plate 50, fig. 11.

Aglaura hemistoma, Péron et Lesueur, 1809, Annals. Mus. Hist. Nat. Paris, tome 14, p. 351.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 248, taf. 8, fign. 13–15.

Aglaura peronii, Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 10, taf. 1, figs. 5–7.

Aglaura hemistoma, Haeckel, 1879, Syst. der Medusen, p. 275, taf. 16, fign. 3, 4.—Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 35 (segmentation), 60 (entoderm), 93 (development of medusa), taf. 7, fign. 1–31; taf. 8, fig. 1; 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 245, taf. 23, figs. 21–23.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 65, plate 25, figs. 79, 80; 1904, Mem. Nat. Sci. Brooklyn Institute Museum, vol. 1, p. 26, plate 4, fig. 34.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 78.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, p. 739; 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 176.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 55; 1902, Biol. Bulletin Woods Hole, vol. 4, p. 14, fig. 1.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 119, plate 2, fig. 6.

Aglaura ciliata, Perkins, 1906, Year Book of the Carnegie Institution Washington, No. 4, 1905, p. 115 (medusa from Tortugas, Florida, with markedly ciliated mouth).—1908, Papers from Tortugas Laboratory of Carnegie Inst. of Washington, vol. 1, p. 148, plate 3, figs. 14-16.

Bell is 3 or 4 mm. in diameter and 4 to 6 mm. high; bell-walls vertical, exceedingly thin, the top quite flat; although thin, the bell is very rigid and swimming is accomplished almost entirely by the movements of the large and powerful velum. About 48 to 85 solid, stiff tentacles which are usually found to be broken off short; when present, however, they are seen to be about three-fourths as long as bell-diameter and their outer ends are slightly club-shaped. 8 small, free sensory-clubs, about midway between the 8 radial-canals, are definitely arranged in reference to the tentacles (see fig. 11, plate 50). Each sensory-club is surrounded by a number of sensory hairs. There is a single concretion within the club. Sometimes this concretion appears to exhibit facets but more often it is simply oval in shape. The 8 radial tubes are straight and very narrow. The stomach is mounted upon a conical peduncle somewhat shorter than the bell-radius. The stomach is flask-shaped and there are 4 prominent, more or less ciliated lips. The 8 sausage-shaped gonads are situated upon the peduncle at the places of juncture of the 8 radial-canals with the stomach. The entodermal core of the stomach and occasionally the entoderm of the gonads display a red-brown pigment.

Common in surface-tows in all warm seas. Abundant in the Atlantic, Mediterranean, Red Sea, Pacific, and Indian Oceans, but unknown from Polar Seas.

The development of *Aglaura hemistoma* has been studied by Metschnikoff, 1886. The egg is 0.09 mm. in diameter and is cast out into the water between 11 and 1 o'clock (mid-day) in April, in the Mediterranean. The segmentation is total but very unequal, the cells of the animal pole being much smaller and dividing more rapidly than those of the vegetative pole of the larva. Soon the small, rapidly dividing cells of the animal pole extend over the sides of the spherical larva and completely inclose the few, large, central cells. These small cells become the ectoderm, while the large central cells give rise to the entoderm. The solid planula then becomes ciliated and elongates, so as to become rod-like with cylindrical sides and rounded ends. The central entoderm then consists of a single row of 10 to 15 disk-like cells, incased by

PLATE 49.

Fig. 1. *Rhopalonema clavigerum*, male medusa. Tortugas, Florida, May 29, 1906. (See page 382.)

Fig. 1′. *Rhopalonema clavigerum.* Aboral view of the medusa shown in figure 1, showing the sequence in arrangement of tentacles and lithocysts.

Fig. 1″. *Rhopalonema clavigerum.* Enlarged view of one of the marginal lithocysts.

Fig. 2. *Aglantha digitale*, mature female. Eastport, Maine, August 20, 1897. (See page 402.)

Fig. 2′. *Aglantha digitale.* One of the marginal lithocyst-clubs.

Fig. 3. *Aglaura hemistoma*, female specimen with moderately long peduncle. Tortugas, Florida, July 6, 1907.

Fig. 4. *Aglaura hemistoma*, male. Tortugas, Florida, June, 1898. Medusa with peduncle of intermediate length and with wide bell.

Fig. 5. *Aglaura hemistoma*, male. Nassau Harbor, Bahamas, March 18, 1893. Medusa with long, narrow bell and short peduncle.

Fig. 6. *Aglaura hemistoma.* Extremity of one of the tentacles from the medusa shown in figure 3.

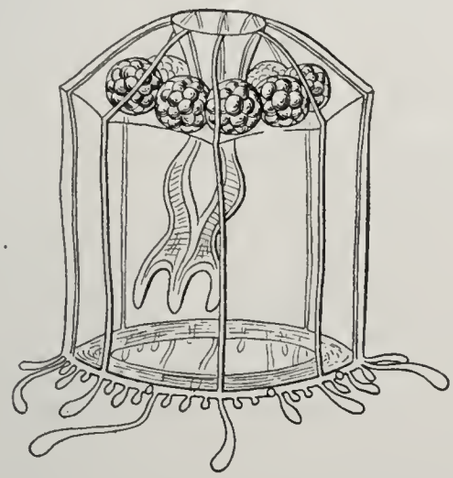
Fig. 7. *Aglaura hemistoma*, marginal lithocyst-club.

Drawn from life, by the author.

1''
1
2
1'
2'
5
4
7
3
6

the small ciliated ectodermal cells. About 26 hours after the egg has been laid, 2 tentacles, 180° apart, grow out from the sides of the larva near the hinder end. The entoderm takes the initiative in the formation of these tentacles, the central cells dividing and pushing the ectoderm outwards. A central cavity then appears in the entoderm of the body of the larva and the conical hypostome forms between the tentacles. Then two more tentacles, 90° from the first pair, grow out and the mouth breaks through. The larva then becomes an actinula with a globular, rounded body and conical-cylindrical neck, and with 4 tentacles, 2 long and 2 short. The ectodermal surface is ciliated throughout. The mouth is now a simple, round opening. Soon 2 more tentacles grow out, 180° apart, quite near the bases of the secondary tentacles and these are soon followed by 2 more tentacles in the same quadrants but near the bases of the 2 primary tentacles. A pair of lithocyst-clubs then appears between the 4 youngest tentacles and another pair of lithocyst-clubs develops 90° from the first. The later development of tentacles appears to be quite irregular. The mouth becomes laterally compressed so as to form a slit having 2 lips 180° apart.

The bell begins to grow out after the lithocyst-clubs have appeared. It begins in 8 lateral expansions of the body wall which soon form a collar-like ring around the body. 8 entodermal radiations from the central stomach enter these 8 lateral expansions and constitute the 8



250.

1

B 251.

A C

Fig. 250.—*Aglaura hemistoma*, after Haeckel.

Fig. 251.—*Aglaura hemistoma*, abnormal medusæ showing lateral fusions between gonads. From life, by the author, Naples Zoological Station. January and February, 1908. *A*, with 3 fused and 2 separated gonads. *B* and *C*, with 8 fused gonads forming umbrella-like expansion around manubrium.

radial-canals of the medusa. This formation of the bell occurs when the larva has 12 tentacles and 4 lithocyst-clubs. There are at first only 2 lips; later a second pair develops, forming a cross with the first. It appears that the actinula larva is converted secondarily into a medusiform adult and the bell forms only after the tentacles and lithocyst-clubs have made their appearance.

Aglaura hemistoma, in common with many other medusæ of world-wide distribution, gives rise to many imperfectly distinguished varieties or local races. I have called certain of these "varieties," more out of respect to their authors than because I believe they represent any natural distinctions. Indeed, out of any collection of a few hundred specimens of *A. hemistoma* it would be possible to construct an even greater number of "varieties." I agree with Vanhöffen, 1902, that *A. hemistoma* is universally distributed throughout all tropical and warm oceans and that its so-called varieties are of no greater importance than are the races of *Aurelia aurita*.

The extremes of the series are represented by *Aglaura "laterna"* and *A. "octagona"* with their long, narrow peduncles, and by *A. nausicaa* with its very short peduncle. *A. prismatica*, *hemistoma*, *vitrea*, and *radiata* form an intergrading series, the first-named having short and the last moderately long peduncles. The peduncles of the various individuals of every swarm of *Aglaura* are, however, remarkably variable in length (plate 49, figs. 3 to 5) and I am inclined to regard this character as of no worth in distinguishing species. I have seen 20 individuals from a single surface-tow at Tortugas, Florida, in which the peduncles ranged from one-fourth to 1.5 times the length of the bell-radius, and yet they appeared alike in all other

respects and were evidently *Aglaura hemistoma*, the average length of the peduncle being about equal to that of the bell-radius.

A curious aberration, shown in text-figure 251, was abundant at Naples, Italy, during the winter of 1907-1908. In nearly every medusa seen during the winter two or more of the gonads were fused laterally. In some cases all 8 gonads were thus fused, forming an umbrella-like expansion around the peduncle. Among thousands of specimens of this medusa from Tortugas, Florida, I have never seen an aberration of this sort.

Aglaura hemistoma var. "nausicaa."

Aglaura nausicaa, Haeckel, 1879, Syst. der Medusen, p. 274, taf. 16, fig. 1.
(?) *Aglaura vitrea*, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, No. 7, p. 277, plate 7, fig. 10.
Aglaura hemistoma, var. *Nausicaa*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K.c., p. 26.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 65.

Distinguished from the typical *Aglaura hemistoma* by the following characters: The bell is egg-shaped, having a rounded contour, and the peduncle is extremely short, being only about one-tenth as long as the stomach. The animal is colorless and transparent. Haeckel found this form in 1877 in the Mediterranean, and the Plankton expedition of 1889 captured it in the Sargasso Sea and also south of the Cape Verde Islands. Young, somewhat contracted, specimens of *Aglaura hemistoma* present the appearance of *A. nausicaa*.

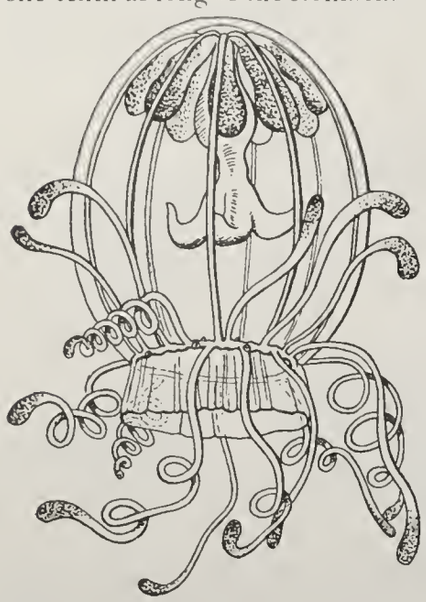


Fig. 252.—*Aglaura "nausicaa,"* after Haeckel, in Das Syst. der Medusen.

Aglaura hemistoma var "prismatica" Maas.

Lessonia radiata (?), Eydoux et Soulfyet, 1841-52, Voyage de la *Bonite*, tome 2, p. 643, Zoophytes, plate 2, fig. 16.
Aglaura prismatica, Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, No. 1, p. 24, plate 3, figs. 4, 5.—Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 165.—Maas, 1905, Craspedot. Medusen *Siboga* Expedition, Monog. 10, p. 58; 1906, Revue Suisse de Zool., tome 14, p. 97, plate 3, fig. 12.

Bell about 3 to 4 mm. in height and about as broad as high; the walls, although rigid, are exceedingly thin; the side-walls of the bell are vertical, the top quite flat, but with a slight apical projection. There are about 60 tentacles, so fragile that they were broken off short in every specimen observed by us. 8 club-shaped lithocysts about midway between the 8 radial-canals; each lithocyst contains a single concretion. Velum very large and powerful and it is chiefly by means of its rapid movements that the medusa is enabled to dart through the water. The 8 radial tubes are straight and very narrow. Manubrium flask-shaped, half as long as depth of bell-cavity including the peduncle. 4 prominent cruciform lips. The 8 sausage-shaped gonads project outward from the sides of peduncle at the point of juncture of the 8 radial tubes with stomach. Gonads and entoderm of stomach usually brownish-red in color, but some specimens are nearly transparent.

Widely distributed over the tropical Pacific, *Aglaura "radiata"* Haeckel is probably only a contracted specimen of *A. prismatica*. I concur with Bigelow, 1909, in the opinion that this so-called "variety" can not be distinguished from *Aglaura hemistoma*.

Aglaura hemistoma var "laterna" Maas.

Aglaura laterna, Haeckel, 1879, Syst. der Medusen, p. 274, taf. 16, fig. 2.
Aglaura hemistoma var. *laterna*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K.c., p. 25, taf. 1, fig. 14.

The bell is 8 mm. in height and 6 mm. in diameter; due to contraction its lower part is an 8-sided prism, while the upper part has the shape of an 8-sided frustum of a pyramid; bell-walls extremely thin. 16 to 32 tentacles, about as long as bell-height, terminating in club-shaped, swollen ends. 8 lithocysts midway between the 8 radial-canals. Velum large, provided with powerful muscles. Peduncle trumpet-shaped, long, and slender, about half as long as bell-height and twice as long as stomach. Stomach spindle-shaped, with four upwardly

curving lips. The 8 spherical or ovoid gonads are situated upon the peduncle a short distance above the stomach. Each gonad arises from the side of a radial tube, the entodermal lumen of the gonad being in direct communication with that of the adjacent radial tube.

Stomach reddish-purple, gonads and lips white. The distal halves of the tentacles are orange and their ends are red.

Distinguished from the typical *Aglaura hemistoma* by the following characters: The peduncle is about 1.5 times as long as in *A. hemistoma*; the gonads are spherical or ovoid in

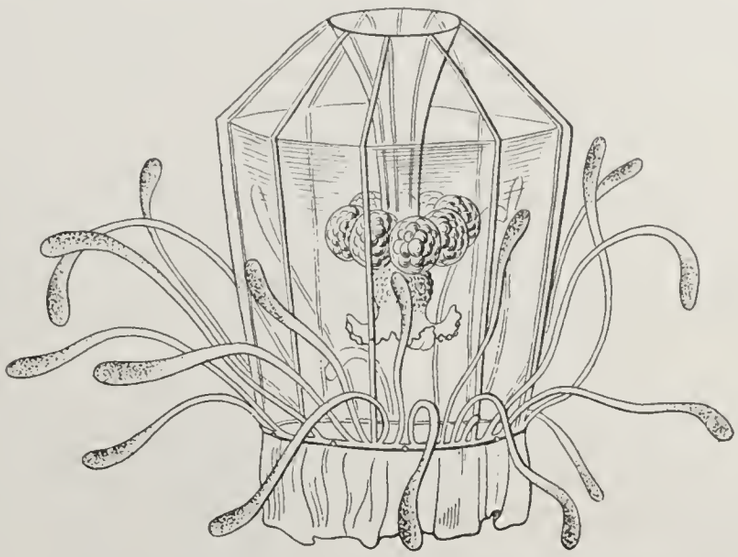


Fig. 253.—*Aglaura "laterna,"* after Haeckel, in Syst. der Medusen.

shape, not sausage-shaped as in *A. hemistoma*, and, finally, the tentacles are only about half as numerous as in *A. hemistoma*. It certainly intergrades with the typical *A. hemistoma* and should be no longer considered as distinctive.

Haeckel found this "variety" in the Canary Islands, in January, 1867, and the Plankton Expedition of 1889 captured it in the Sargasso Sea.

Aglaura hemistoma var. "octagona."

Aglaura octagona, Bigelow, H. B., 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 257, plate 2, fig. 9.

Bell octagonal, with slightly bulging sides and truncated, prismatic top, 1.5 mm. wide, 3 mm. high; walls exceedingly thin, but very rigid. About 32 tentacles, 8 interradial sensory-clubs. Velum is provided with a series of circular muscles. Peduncle narrow, trumpet-shaped, fully 1.5 times as long as bell-radius. 8 egg-shaped gonads are borne at points of junction of the 8 slender radial-canals with stomach. Stomach about one-fourth as long as peduncle, 4 simple, recurved lips. Colorless. Found off Kolumadulu Atoll, Maldive Islands, Indian Ocean, from a depth of 100 fathoms to surface, on December 30, 1901.

This "variety" may be identical with *Aglaura laterna* Haeckel, of the Canary Islands.

Genus AGLANTHA Haeckel, 1879.

Circe, Brandt (Mertens), 1834, Recueil Actes Acad. Sci. St. Pétersbourg, p. 201.—Forbes, 1848, British Naked-eyed Medusæ, p. 34.—Lesson, 1843, Zooph. Acal., p. 285.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 349.
Trachynema, Agassiz, A., 1865, North Amer. Acal., p. 55.
Aglantha+Agliscra, Haeckel, 1879, Syst. der Medusen, pp. 271, 276.
Aglantha, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 23; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 494.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 121.

The name "*Circe*" was preoccupied in 1817 by Schumacher who applied it to Mollusca. "*Trachynema*" of Gegenbaur, 1854, was applied to *Trachynema ciliatum*, a larval medusa of the Mediterranean, that is certainly generically distinct from "*Trachynema*" of A. Agassiz, 1865. In 1879, Haeckel proposed the name *Aglantha* which is thus the first distinctive term applied to the genus.

GENERIC CHARACTERS.

Aglaurinæ with 8 gonads situated upon the 8 radial-canals. These gonads are attached to the subumbrella, or to the zone between the subumbrella and the peduncle; not situated upon the peduncle as in *Aglaura*. The medusæ are not hermaphroditic as in *Amphogona* Browne.

Haeckel distinguishes *Aglantha* with 4 and *Agliscra* with 16 lithocyst-clubs.

The common *Aglantha digitale* of the New England coast is, however, very variable in the number of its sensory-clubs, ranging in specimens observed by me from 3 to 8. Moreover, these clubs are very readily lost and appear to be too variable, even when present, to afford suitable data for generic distinctions, and it would seem desirable to unite the above genera under the name *Aglantha*.

Maas, 1893, distinguishes *Aglantha* with 8 gonads upon the turning points in the 8 radial-canals between the peduncle and the subumbrella; and *Agliscra* with gonads upon the subumbrella. It is, however, a difficult matter to decide whether the gonads are upon the subumbrella or upon the turning points of the canals at the base of the peduncle. Moreover, such a classification would in my opinion unduly restrict the genus *Aglantha*. The exact position of the 8 gonads, on the other hand, provides us with a ready means of distinguishing *species* one from another.

Vanhöffen, 1902 (*Valdivia*, Bd. 3, Lfg. 1, p. 76) would amend Haeckel's *Agliscra* to include Aglauridæ with 8 linear gonads attached throughout their lengths, not merely suspended from the 8 radial-canals. There are, however, species or varieties of *Aglantha* with globular, neither suspended nor sausage-shaped, gonads, and when young the medusæ of *Aglantha digitale* have linear gonads. Moreover, Haeckel's type species of *Agliscra* has suspended, sausage-shaped gonads.

Aglantha is closely related to *Aglaura*, but in the latter genus the 8 gonads are developed upon the 8 radial-canals on the peduncle above the stomach.

Amphogona Browne is doubtfully distinguished by its being said to be hermaphroditic, 4 of the radial-canals bearing male gonads and the 4 canals which alternate with them bearing female genital organs (see Bigelow, 1909, p. 126).

Aglantha digitale Haeckel.

Plate 49, figs. 2 and 2′.

Digitale (*medusa*), Müllfr, O. F., 1766, Prodrom. Zool. Dan., p. 233, No. 2824.—Fabricius, 1870, Fauna Grönlandica, p. 366, No. 361.

Melicerta digitale, Péron et Lesueur, 1809, Ann. Mus. Hist. Nat. Paris, tome 14, p. 352, No. 72.

Dianæa digitale, Lamarck, 1817, Anim. sans Vert., tome 2, p. 507.

Eirene digitale, Eschscholtz, 1829, Syst. der Acalephen, p. 95.

Turris borealis, Lesson, 1843, Hist. Zooph. Acal., p. 284.

Circe rosea, Forbes, 1848, British Naked-eyed Medusæ, p. 34, plate 1, fig. 2.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 349.

Turris (*Circe*) *digitalis*, Mörch, 1857, Beskriv af Grönland, p. 95.

Trachynema digitale, Agassiz, A., 1865, North Amer. Acalephæ, p. 57, figs. 81–86.

Circella digitalis, Haeckel, 1877, Prodrom. Syst. der Medusen, No. 287 (unpublished).

Aglantha digitalis, Haeckel, 1879, Syst. der Medusen, p. 272, taf. 16, fign. 5, 6.—Hartlaub, 1894, Cœlenteraten Helgolands, Meeresfauna von Helgoland, p. 197, Kiel und Leipzig.—Fowler, 1899, Proc. Zool. Soc. London, p. 1031.—Maas, 1891, Sitzungsber. Akad. Wissen. Berlin, p. 336; 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., pp. 23, 24.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 55, 1 fig.; 1902, young medusa, *Aglantha conica*, Biol. Bulletin Woods Hole, vol. 4, p. 21, fig. 7; *Ibid.*, vol. 14, p. 111.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 78.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 509 (review of literature).

Trachynema digitale, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 160, plate 2, figs. 5, 6.—Nutting, 1901, Bull. U. S. Fish Commission, vol. 19, p. 381, fig. 102.

(?) *Aglantha rosea*, Browne, 1898, Proc. Zool. Soc. London for 1897, p. 833, plate 49, figs. 1., 1*a*, 1*b*.

Aglantha rosea + *A. digitalis*, Browne, 1903, Bergens Museums Aarbog, No. 4, pp. 22, 23.

Aglantha rosea, Browne, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, p. 175.—Fowler, *Ibid.*, p. 182.—Günther, 1903, Annals and Mag. Nat. Hist., ser. 7, vol. 11, p. 427, plate 10, figs. 6–8.

Circe camtschatica, Brandt, 1838, Mém. Acad. Sci. St. Pétersbourg, sér. 6, tom. 4, p. 354, planche 1, figs. 1–5 (coast of Kamtschatka).

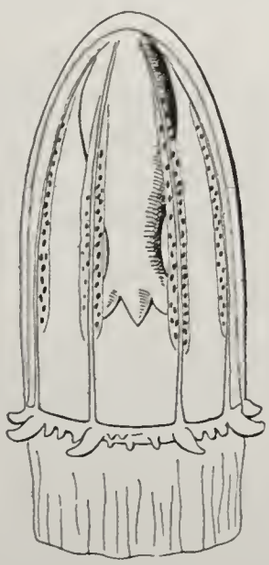
Trachynema camtschatica, Agassiz, A., 1865, North Amer. Acal., p. 55, figs. 76–80 (from Gulf of Georgia, Pacific).

Adult medusa (plate 49, fig. 2).—Bell about 30 mm. in height, 15 mm. in diameter; bell-walls are extremely thin, but quite rigid, so that swimming is accomplished by means of the pulsations of the large and powerful velum. The bell terminates in a small, solid, conical

apex. About 80 to 100 long, slender tentacles having only a moderate degree of contractability. These tentacles are very brittle and in medusæ caught in tow-nets are usually broken off very near to bell-margin, leaving only short stumps. In the majority of individuals there are 4 lithocysts (plate 49, fig. 2′) situated 90° apart and midway between every alternate pair of radial tubes. I have, however, found individuals with 3, 5, 6, and 8 lithocysts, and the figure shows one having 8 lithocysts. It is probable that the normal complete number is 8, but that the concretions are easily lost. Velum large, provided with powerful muscles. 8 very narrow, straight radial-canals and a simple, slender, circular vessel. A long, spindle-shaped, gelatinous peduncle extends from inner apex of subumbrella almost to level of bell-margin. 8 radial tubes extend straight down this peduncle to the stomach, which is short and cylindrical and provided with 4 prominent lips. 8 sausage-shaped gonads arise from the sides of the 8 radial tubes near inner apex of subumbrella and hang downward into cavity of bell. Females only have been observed. The ova are large and prominent. The bell is translucent and displays a dull-horny or iridescent appearance. The gonads are of a milky, yellow-white color and the entoderm of the stomach and tentacles is pink.

Young medusa.—In young medusæ about 4 mm. in height, the bell is quite globular, the tentacles are much less numerous than in the adult, and the gonads have not yet made their appearance. Moreover, the peduncle is at this stage very little developed, so that the mouth

255.



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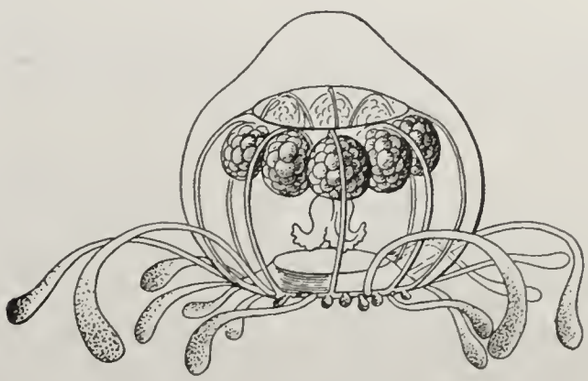


254.

Fig. 254.—*Aglantha globuligera*, after Haeckel, in Das System der Medusen.
Fig. 255.—"*Aglantha elata*," after Haeckel, in Syst. der Medusen.
Fig. 256.—*Aglantha ignea*, after Vanhöffen, in Tiefsee Expedition *Valdivia*.

projects but a little distance downward from the inner apex of the bell-cavity. As the medusa develops, the bell increases relatively in height, the tentacles become more numerous, the peduncle elongates, and the gonads finally make their appearance.

Aglantha camtschatica described by Brandt, 1838, from the North Pacific, is probably identical with *A. digitale* of the North Atlantic.

This medusa is extremely abundant all over the North Atlantic, north of latitude 45°. It does not appear to extend south of latitude 40° in the Atlantic. In common with other Arctic species, it makes its appearance in great numbers upon the southern coast of New England early in the spring, but disappears before June. It remains common throughout the summer, however, in the harbor of Eastport, Maine. The Plankton Expedition, of 1889, met with great swarms of this medusa between the Hebrides and Greenland during July. Browne found it in Fowler's collection from the Bay of Biscay, made at a depth of 100 fathoms.

Browne calls medusæ with 8 lithocyst-clubs "*A. rosea*," while *A. digitale* he would restrict to include medusæ with only 4 of these organs. I believe that the medusa usually becomes

mature with 4, but occasionally develops 8 lithocysts, and that *A. "rosea"* is only a phase in the growth of the medusa.

The figures of *A. camtschatica* of the North Pacific given by Mertens (Brandt) and by A. Agassiz show that this medusa is probably identical with *A. digitale* of the North Atlantic. Their drawings show a much shorter peduncle than is seen in the adult, *A. digitale* of the Atlantic, but their specimens appear to have been of smaller size and were possibly not fully grown, although with well-developed gonads. A. Agassiz's, 1865, figures illustrate these points very clearly. At most the North Pacific medusa appears to me to be but a close variety of *A. digitale*.

Aglantha digitale var. "occidentalis" Maas.

Aglantha occidentalis, n. sp. oder *A. digitalis* var. *occidentalis*, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 24.

In this variety, according to Maas, the bell is not as high as in *Aglantha digitale*, but is more than twice as broad. The bell attains a height of 15 to 20 mm. The gonads make their appearance when the bell-height is only 6 mm., whereas in the typical *Aglantha digitale* the bell is more than 15 mm. high before the gonads are seen. This variety was found by the Plankton Expedition in the West Greenland Stream and on the Newfoundland Banks in July and August.

Aglantha digitale var. intermedia Bigelow.

Aglantha digitale var. *intermedia*, Bigelow, H. B., 1909, Mem. Mus. Comparative Zool. at Harvard College, vol. 37, p. 112, plate 29, figs. 4–10.

Bell 14 mm. wide, 15 mm. high. 80 to 90 tentacles. The 8 radial-canals do not proceed straight down the peduncle as in *A. digitale* but are arranged in 4 pairs each of which bends in an S-like manner. The gonads do not begin to develop until the medusa is about 5 mm. high. This variety is larger than *A. digitale* and has more tentacles. Described by Bigelow from the eastern tropical Pacific between 13° S. and 20° N. lat. in the intermediate fauna between 400 fathoms and the surface. 36 specimens were collected by the *Albatross* expedition of 1904–05.

Aglantha globuligera Haeckel.

Aglantha globuligera Haeckel, 1879, Syst. der Medusen, p. 272, taf. 16, fig. 8.

This species is said to be distinguished by its small size, pyriform, rounded bell, spherical gonads, and by having not more than 32 tentacles. Bell pyriform with bluntly-rounded apex and barrel-shaped sides, 2 mm. high, 2 mm. wide. The gelatinous substance thick at apex but quite thin at sides. 32 tentacles with club-shaped, swollen ends, the longest not quite as long as bell-diameter. 4 interradial sensory-clubs. Velum well developed. Peduncle conical, about one-fourth as long as bell-height and about as wide at base as bell-radius. Stomach urn-shaped, as long as peduncle; 4 large, recurved lips as long as stomach. 8 spherical gonads are situated upon the 8 radial-canals at points of juncture of peduncle with subumbrella; the diameter of each gonad is equal to length of peduncle. Medusa colorless. Found in the Canary Islands, in February. (See fig. 254.)

Aglantha elongata.

Circe elongata, Lesson, 1843, Hist. Zooph. Acal., p. 286, plate 5, fig. 2.
Agliscra elata+*A. elongata*, Hafckel, 1879, Syst. der Medusen, pp. 276, 277, taf. 16, fig. 2.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 30.
(?) *Circe invertens*, Allman, 1873, Nature, London, vol. 9, p. 74.

This species is distinguished by its narrow, elongate bell and by the fact that the 8 gonads arise from the sides of the subumbrella, not from the base of the peduncle as in *A. digitale*. Moreover, there are 16 sensory-clubs instead of 4 to 8 as in *A. digitale*.

The bell is 3 to 4 mm. wide, 10 to 12 mm. high with cylindrical sides and conical apex. About 50 or more marginal tentacles, 16 lithocysts, 2 in each octant. Peduncle cylindrical, half as long as bell-height. Stomach very small, only one-eighth as long as peduncle; 4 triangular lips as long as stomach. 8 sausage-shaped gonads are suspended from the middle points of the 8 radial-canals on the subumbrella; gonads are each about as long as peduncle. Medusa rose-colored. (See fig. 255.)

Haeckel describes this medusa from the Cape of Good Hope, Africa, and Maas records it from the Bay of Biscay, and from the Guinea Stream, off the west coast of Africa.

Lesson's *Circe elongata* is probably identical with Haeckel's *Agliscra elata*, and Vanhöffen's *Agliscra ignea* from the Indian Ocean may possibly be a stage in the growth of the same medusa. Allman's *Circe invertens* from off the south coast of Ireland is probably identical with this medusa.

Aglantha ignea.

Agliscra ignea, Vanhöffen, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 76, taf. 9, fig. 10.

Bell 14 mm. high, 7 mm. wide. 32 tentacles, 8 large radial and 24 small interradial. Lithocysts (?) 8 narrow, straight radial-canals with 8 linear gonads attached throughout their entire lengths to middle halves of radial-canals. Manubrium half as long as the depth of the bell-cavity, with 4 simple lips. Velum very wide and projecting beyond the bell-margin. Color of entodermal lamella and all entoderm bright-red. Tropical Indian Ocean, 750 to 1,000 fathoms. This may be a stage in the growth of *A. elongata* (?). (See text-figure 256.)

Genus AMPHOGONA Browne, 1904.

Amphogona, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, pp. 724, 739.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 125.

The type species is *Amphogona apsteini* of the Indian Ocean, Maldive Islands to Sumatra. This was described by Vanhöffen, 1902, as *Pantachogon apsteini*.

GENERIC CHARACTERS.

Aglaurinæ with 8 gonads upon the subumbrella parts of the 8 radial-canals. 4 of the gonads are male and alternate with 4 female gonads.

This genus is closely related to *Aglantha*, but is separated by its bisexual gonads. Browne discovered this fact upon sectioning the gonads. It is known, however, that this bisexual condition is not constantly present, for Bigelow sectioned a similar medusa and found all of the 8 gonads to be of one sex.

Amphogona apsteini Browne.

Pantachogon apsteini, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 65, taf. 10, fig. 18; taf. 11, fig. 28.

Amphogon apsteini, Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 740, plate 54, fig. 5; plate 56, fig. 1; plate 57, figs. 10–15.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 126, plates 2, 34, 45.

Bell somewhat flatter than a hemisphere, 4.25 mm. wide, 1.75 mm. high. Bell-walls thin. About 70 marginal tentacles, similar each to each and somewhat shorter than bell-radius, filiform and ringed at fairly regular intervals by nematocysts; their entoderm consists of a single row of chordate cells. About 16 to 20 marginal sense-organs arise from bell-margin between the tentacles, 1 to 3 in each octant. Each marginal sense-organ consists of a club with a vesicular cavity containing a single spherical concretion. Velum is quite broad. 8 straight, slender radial-canals and a simple ring-canal. Stomach small, mounted upon a narrow, tapering peduncle down which the 8 radial-canals extend. The mouth is about at level of velar opening; 4 simple, short, recurved lips. The 8 sausage-shaped gonads are suspended from the 8 radial-canals near the ring-canal. In Browne's medusæ 4 of these gonads are male and they alternate with 4 female gonads, every other radial-canal bearing a gonad of opposite sex. In Vanhöffen's specimens, 4 interradial gonads were small and 4 on the perradial canals were larger, but in Browne's well-developed medusæ the gonads were all of equal size. The male and female gonads appear to be equally advanced in development at one and the same period. This is one of the few cases of hermaphroditism in Hydromedusæ, other examples being found in *Eleutheria* and *Cladonema*. Bigelow finds the gonads of a medusa similar to Browne's *Amphogona* to be unisexual. The hermaphroditism may, therefore, be only an aberration or a temporary matter, as in *Cladonema*. The medusa is colorless.

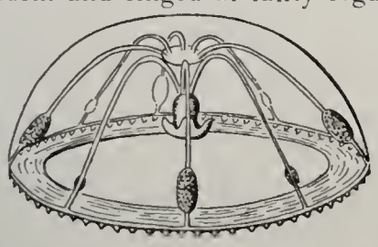


Fig. 257.—*Amphogona apsteini*, after Vanhöffen, in Tiefsee Expedition *Valdivia*.

Found near the surface in the Maldive Islands, Indian Ocean (Miladummadulu Atoll), and off the west coast of Sumatra. Browne gives a good series of figures of this medusa. Bigelow, 1909, found 6 specimens of this medusa in Acapulco Harbor, Pacific coast of Mexico, on February 28. The largest specimen was 6 mm. wide, with somewhat conical bell and thin, but rigid, gelatinous substance. About 64 tentacles. When young there are 4 small, alternating with 4 large, gonads, but in later life all gonads become of one and the same size. Bigelow found upon sectioning his medusæ that all of the gonads in any one medusa were of one and the same sex, thus casting doubt upon Browne's conclusion.

Genus STAURAGLAURA Haeckel, 1879.

Stauraglaura, Haeckel, 1879, Syst. der Medusen, p. 277.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 496.

The only known species is *Stauraglaura tetragonima* Haeckel, from the coast of Australia.

GENERIC CHARACTERS.

Aglaurinæ with 4 gonads upon every alternate one of the 8 radial-canals, leaving every alternate radial-canal sterile. This genus resembles *Tetrorchis* Bigelow, but is distinguished by having a gelatinous peduncle above the stomach.

Stauraglaura tetragonima Haeckel.

Stauraglaura tetragonima, Haeckel, 1879, Syst. der Medusen, p. 277, taf. 16, fign. 10, 11.

12 mm. high, 8 mm. broad, bell-shaped with octangular sides and small conical apex. 60 to 80 tentacles, 4 lithocyst-clubs apparently in the radii of the lips. Velum very wide. Peduncle slender and cylindrical, half as long as bell-height. Stomach small, bell-shaped, hardly one-fourth as long as peduncle, 4 very short, wide, triangular lips. 4 spherical gonads, each about twice as large as stomach, upon the peduncle adjacent to stomach. Haeckel studied two preserved specimens and states that there are 8 radial-canals on the subumbrella, but apparently only 4 along the peduncle. The 4 peduncular canals may, therefore, bifurcate, but of this he is not certain. At any rate, there are only 4 gonads. Coast of Australia. Exact arrangement of the gonads, lips, sense-clubs, and radial-canals (?)

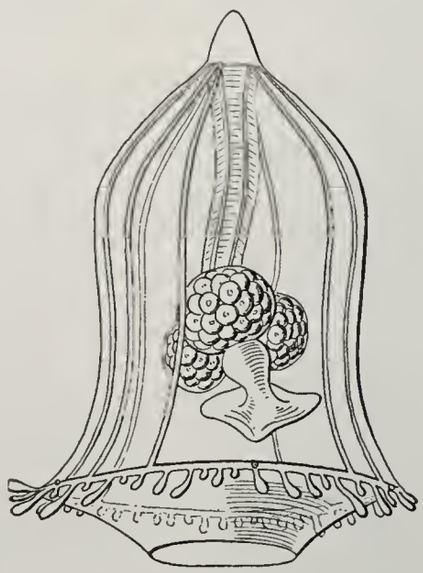


Fig. 258.—*Stauraglaura tetragonima*, after Haeckel, in Syst. der Medusen.

Genus PERSA McCrady, 1857.

Persa, McCrady, 1857, Gymn. Charleston Harbor, p. 104.—L. Agassiz, 1862, Cont. Nat. Hist. U. S., vol. 4, p. 278.—Haeckel, 1879, Syst. der Medusen, p. 278.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 496.

The type species is *Persa incolorata* McCrady, of the southern Atlantic coast of the United States.

GENERIC CHARACTERS.

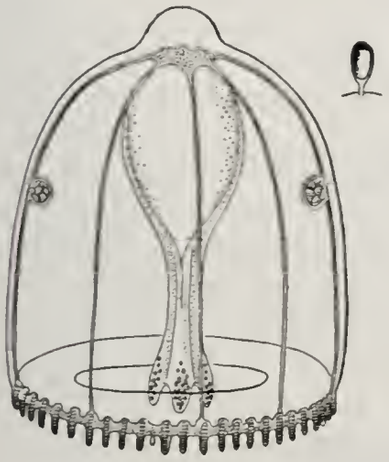
Aglaurinæ in which only 2 of the 8 radial-canals bear gonads. The 2 gonads are 180° apart and are situated upon the subumbrella portions of the radial-canals.

Haeckel enumerates three "species," but the differences between them are so slight that it seems probable that there is but one true species and this should be called *P. incolorata*. A synopsis of these forms is given in the following table.

Haeckel's so-called lantern-shape of the bell is due to contraction, yet he attempts to distinguish two "species" upon the presence or absence of this character.

On December 11, 1907, I found an immature *Persa* in the Bay of Naples, Italy. The bell was 1 mm. high and oval, with a solid dome-like apex. There were 46 tentacles all broken off short. The 16 radial and interradial tentacles had each a brilliant ruby-red spot in the ento-

derm of their axial cores within the gelatinous substance of the bell. There was only one interradial, naked lithocyst-club. The velum was very wide. The manubrium lacked a peduncle, due probably to immaturity. There were 4 lanceolate nematocyst-studded lips. The 8 straight, very narrow radial-canals were perradial and interradial in reference to the lips. The 2 small, immature, vesicular gonads were perradial, 180° apart, and at the middle points of two diametrically opposed radial-canals.



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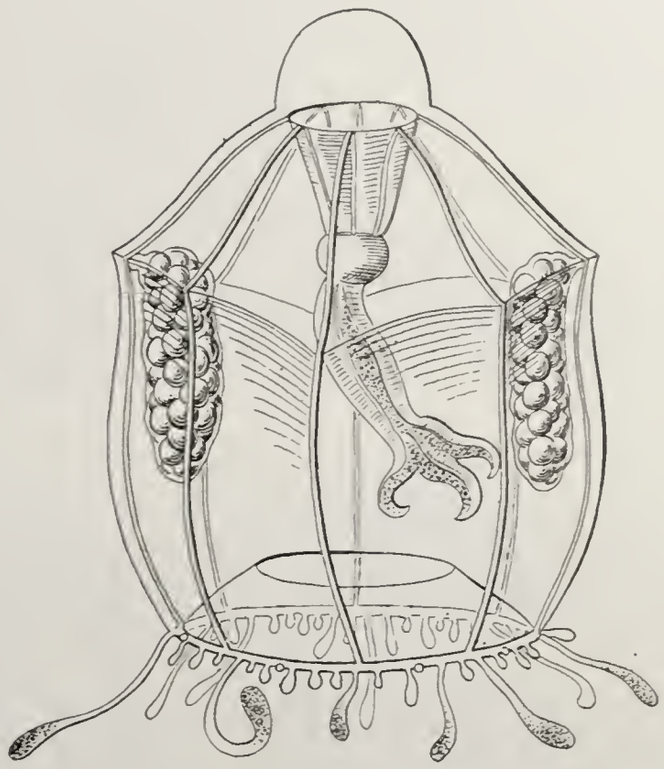

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Fig. 259.—*Persa lucerna*, after Haeckel, in Syst. der Medusen.

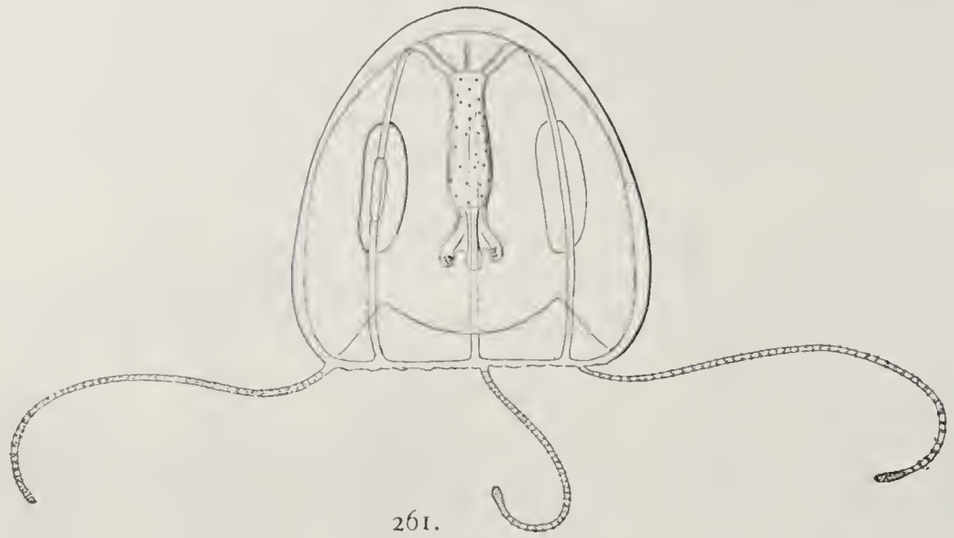
Fig. 260.—*Persa*, sp. Young medusa. From life, by the author. Naples Zoological Station, Dec. 11, 1907. Showing an enlarged view of one of the marginal sense-clubs.

Synopsis of the Described Forms of Persa.

	P. incolorata, McCrady.	P. lucerna Haeckel,* 1879, Syst. der Medusen, p. 278, taf. 16, figs. 12, 13.	P. dissogonima Haeckel,* 1879, p. 279.
Size of bell in mm.	2 high, 1.2 wide.	2 high, 2 wide.	3 high, 2 wide.
Shape of bell.	Bell-shaped.	Octagonal and prismatic below, pyramidal, with hemispherical apex above.	Lower half cylindrical, upper hemispherical, with small hemispherical apex.
Number of tentacles.	60 to 80	40 to 60	32
Number of lithocyst-clubs.	8	8	8
Length of peduncle in terms of bell-radius (r).	One-third $r-$.	0.5 r, conical.	One-third $r-$.
Form of stomach.	Cylindrical, with 4 lanceolate lips. Stomach long.	Cylindrical, r long, with 4 long, lanceolate lips.	As in P. lucerna, but with wide, short lips.
Shape and size of gonads.	Sausage-shaped, $r+$ long.	As in P. incolorata.	As in P. incolorata.
Color.	Colorless.	Haeckel calls it colorless. A living specimen studied by me at Naples had a ruby-red spot in the entoderm above the origins of 16 of its 46 tentacles.	Colorless.
Where found.	Coast of North and South Carolina, United States.	Corfu, Mediterranean. Common.	Algeciras, Strait of Gibraltar. Rare.

*Haeckel's so-called "species" are probably identical with *P. incolorata*, McCrady.

Persa incolorata McCrady.



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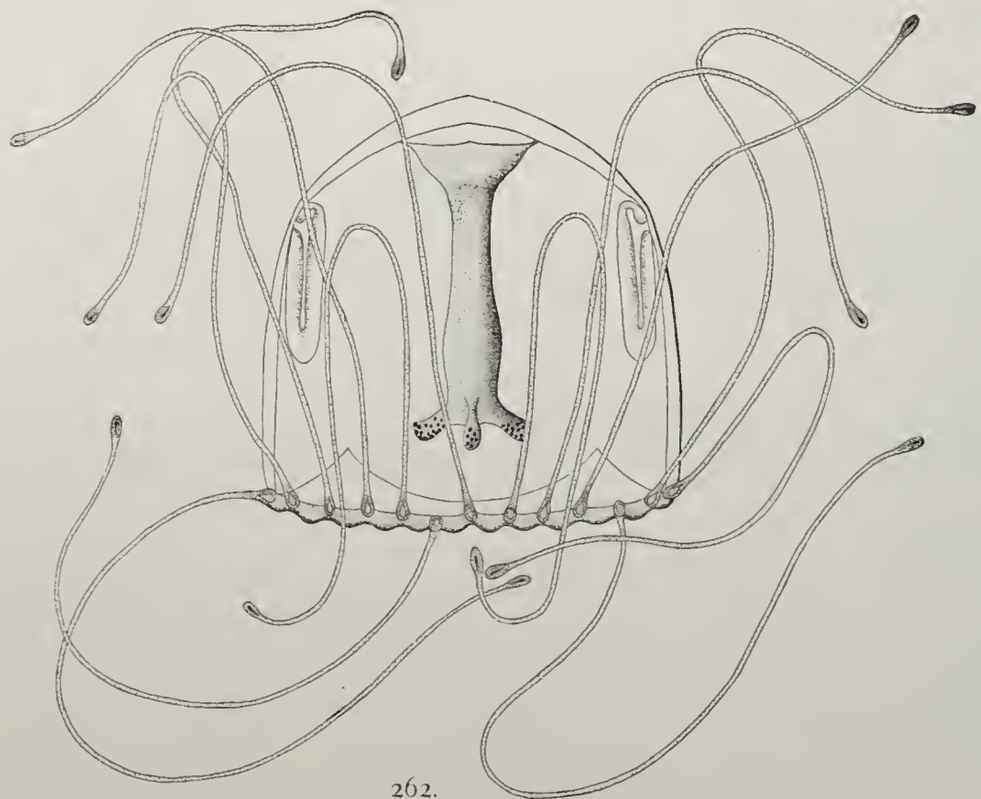

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Fig. 261.—*Persa incolorata*, young medusa, from Beaufort, North Carolina.

Fig. 262.—*Persa incolorata*, mature medusa, from Beaufort, North Carolina.

Drawn from life, by Prof. W. K. Brooks.

Persa incolorata, McCrady, 1857, Gymn. Charleston Harbor, p. 104, plate 12, fig. 3.—Agassiz, A., 1865, North Amer. Acal., p. 50.—Haeckel, 1879, Syst. der Medusen, p. 279.

Bell oval and about 3 mm. in height and 1.5 mm. in diameter; walls thin. There are a large number of long, brittle, club-shaped, ciliated tentacles. 8 sensory-clubs between the 8

radial tubes. Velum large and muscular. 8 very narrow, straight radial tubes and a slender circular vessel. Peduncle short and conical. Stomach cylindrical, about half as long as bell-height, with 4 long cruciform lips. The 2 gonads are developed on 2 diametrically opposed radial tubes. They arise from these tubes upon the subumbrella and project inward into the bell-cavity.

The animal is transparent, excepting for the gonads, which are pale-yellow.

This rare species was found by McCrady in 1857 in Charleston Harbor, South Carolina, and Brooks has found it in abundance during the summer at Beaufort, North Carolina. I believe it to be identical with the Mediterranean *Persa*.

The figures of the medusa here presented were drawn from nature by the late Professor William K. Brooks, who kindly presented them to me for use in this work.

Family GERYONIDÆ Eschscholtz, 1829, sens. restrict.

Geryonidæ (in part), Eschscholtz, 1829, Syst. der Acalephen, p. 86.

Geryonidæ, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 252.—Haeckel, 1879, Syst. der Medusen, p. 280.—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 27; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 59; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 489.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 82.—Browne, 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Suppl. Report 27, p. 151.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 111.

FAMILY CHARACTERS.

Trachymedusæ with 4 or 6 radial-canals upon which the leaf-like gonads are developed. The lithocyst-clubs are in inclosed sacs buried in the gelatinous substance of the bell above the ring-canal. The stomach is mounted upon a peduncle. There may be blindly-ending, centripetal canals between the radial-canals. Development is through a free-swimming actinula, which becomes transformed into the medusa.

The Geryonidæ are distinguished by their expanded, leaf-like gonads. The tentacles also undergo a peculiar process of development. The stiff, solid, radially placed tentacles of the actinula-like larva are soon replaced by hollow, flexible, radially placed tentacles, growing out from the bell-margin below the level of the original solid tentacles. In the meantime a set of solid, stiff, interradial tentacles has developed. Thus in *Liriope* we have 4 primitive, solid, perradial tentacles, 4 secondary solid, interradial tentacles, and 4 hollow, flexible, perradial marginal tentacles which develop last of all. The same process takes place in *Geryonia* excepting that in this genus there are 6 tentacles of each set.

The stomach in Geryonidæ is always mounted upon a peduncle and this is provided with longitudinal interradial muscles enabling it to bend from side to side and even to contract to a limited degree. Interradial, blindly-ending, centripetal canals are probably universally present in adult medusæ, but they can usually be detected only after treatment with osmic acid, for in life the bells of these medusæ are of such glassy transparency that many details of their structure are invisible.

Being independent of the shallows of coasts for their development the Geryonidæ are *par excellence* creatures of the open ocean, and thus it is that many of the species are of circumterrestrial distribution. They are, however, confined to tropical and warm oceans and are not known from polar regions.

There are a great many local races and closely-related varieties, so intimately and complexly related and displaying so many intergrading forms that the Linnean system actually fails when we attempt to apply it to their classification and arrangement.

The genera of the Geryonidæ are as follows:

Liriope Lesson, 1843 = *Liriantha* + *Liriope* + *Glossoconus* + *Glossocodon* Haeckel, 1879. 4-rayed Geryonidæ with 4 radial-canals. 4 lips, 4 gonads, and with one or more blindly-ending, centripetal vessels in each interradial quadrant. With 4 primary, solid, radial, 4 solid, interradial, and 4 hollow, flexible, radially placed tentacles, which develop last of all and usually replace the 4 primitive tentacles.

Geryonia Péron and Lesueur, 1809 = *Geryones* + *Geryonia* + *Carmaris* + *Carmarina* Haeckel, 1879. Similar to *Liriope*, but with 6 rays instead of 4.

Genus LIRIOPE Lesson, 1843.

Liriope, Lesson, 1843, Hist. Zooph. Acalèphes, p. 332.—Metschnikoff, 1881, Zeit. für wissen. Zool., Bd. 36, p. 436 (development); Arbeit. Zool. Inst. Wien., Bd. 6, p. 246.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 383.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 35; 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 24; 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 25.—Zoja, 1895, Archiv. für Entwick. Mech., Bd. 1 und 2.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 79.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, p. 738.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 111.

Liriantha + *Liriope* + *Glossoconus* + *Glossocodon*, Haeckel, 1879, Syst. der Medusen, pp. 286, 288, 292.

The type species is *Liriope exigua* = *Liriope cerasiformis* Lesson, of the Mediterranean. This form is probably identical with the following:

L. appendiculata Forbes, 1848; *L. exigua* Haeckel, 1879; *L. mucronata* Gegenbaur, 1856; Hertwig, 1879; Haeckel, 1879; *L. scutigera* A. Agassiz, 1865; (?) *L. cerasus* Haeckel, 1879.

While *L. cerasiformis* is Lesson's type, the oldest known species was described by Chamisso and Eysenhardt, 1821, from the Indian Ocean under the name *Geryonia tetraphylla*. This is probably identical with *S. rosacea* and possibly also with *L. exigua*.

GENERIC CHARACTERS.

4-rayed Geryonidæ with 4 radial-canals, 4 lips, 4 gonads, and one or more blind, centripetal canals in each interradial quadrant. With 4 primary, solid, radial, 4 permanent, hollow, radial, and 4 solid, interradial tentacles, all 12 of which may be found upon the medusa at one and the same time. 8 inclosed lithocysts, 4 radial and 4 interradial. Development direct.

Haeckel, 1879, divides the genus *Liriope* into four genera based on the presence or (apparent) absence of blind centripetal vessels and of 4 or 8 tentacles. Metschnikoff, Maas, and Vanhöffen have shown that centripetal canals are probably invariably present and range from 1 to 7 in each interradial quadrant. The tentacles may range from 4 to 12, for the 4 primary tentacles are almost certain to be lost before the medusa becomes mature, and very frequently the 4 solid, interradial tentacles are also lost, leaving only the 4 hollow, radial tentacles. It is evident, therefore, that Haeckel's genera are separated upon fictitious distinctions and should be abolished and classified under the old generic name *Liriope*.

The development of *Liriope* has been studied by Metschnikoff and by Brooks. The medusa develops directly from a free-floating, actinula-like larva (see *L. mucronata* and *L. scutigera*). The 4 radial-canals are separated by 4 interradial adhesions of the entodermal layers of the primitive stomach-cavity. The primitive, solid radial tentacles disappear and the solid interradial and hollow radial tentacles develop.

Zoja, 1895, carried out some interesting experiments upon *Liriope*. Normally the entoderm is formed by delamination from the inner ends of the cells of the blastula at the 16-cell stage. If we mechanically divide the 2-cell stage into two separate cells, each component gives rise to the entoderm when it has divided into 16 cells, and not at its 8-cell stage, as might possibly have been expected. In other words, the isolated cells of the 2-cell stage behave as original ova and recommence the process of forming the embryo.

In common with other Trachymedusæ the species of *Liriope* are very widely distributed, being abundant in all warm seas although unknown from polar regions. The species are exceedingly difficult to separate, for the shape of the gonads, length of peduncle, and number of centripetal canals are apt to be variable, and also change greatly in appearance as growth proceeds. Vanhöffen, 1902, concludes that the shape of the gonads affords the surest criterion for the separation of species. He would group the species about the following type forms:

(1) *L. tetraphylla* Chamisso and Eysenhardt, with long, oval, egg-shaped gonads. Indo-Pacific region.
(2) *L. eurybia* Haeckel, with oval or leaf-shaped gonads. Atlantic and Mediterranean.
(3) *L. cerasiformis* Lesson, with heart-shaped gonads.
(4) *L. rosacea* Eschscholtz, with gonads of the shape of an equilateral triangle.
(5) *L. lutkeni* Haeckel, with 5-sided, maple-leaf-shaped gonads.

The following table will serve to point out the principal distinctions between the described forms of *Liriope:*

Synopsis of the Species of Liriope.

	Cerasiformis Group, with Heart-shaped Gonads.				
	L. appendiculata Forbes, 1848.	D. exigua Quoy et Gaimard, 1827 = L. cerasiformis Lesson, 1843.	L. mucronata Gegenbaur, 1856.	L. hemisphericus Bigelow, 1904.	L. cerasus Haeckel, 1879.
Thickness of gelatinous substance of bell.	Thick.	Thick.	Thick.	Fairly thick.	Thick.
Size of bell in mm.	15 wide, 8 high.	16 to 20 wide, 10 to 15 high.	12 wide, 6 high.	8 wide, 4.2 high.	25 wide, 20 high.
Length of peduncle in terms of bell-radius (*r*).	2 *r*	2 *r*±	2 *r*	2 *r*	4 *r*
Shape of gonads.	Heart-shaped.	Heart-shaped.	Heart-shaped, long.	Heart-shaped, long, narrow, pointed outwardly.	Heart-shaped, wide.
Position of gonads.	Extending close to margin.	On middle thirds of 4 radial-canals.	Nearly touching margin.	On proximal halves of 4 radial-canals.	Close to bell-margin.
Distance between gonads in terms of width of gonads (*b*).	*b* to 2*b*	*b*	*b*+	3 to 4*b*	One-fourth *b*.
Number of centripetal canals in each interradial quadrant.	?	1 to 3	1 to 3	1 wide, pointed.	?
Color.	Gonads green, tentacles red.	Entodermal parts pink, rose-red, green, or colorless.	Colorless.	Gonads opaque, whitish. Nettle-cells of interradial tentacles vandyke brown.	Gonads rose-red or grass-green.
Where found.	Atlantic Ocean, British coast.	Warm parts of Atlantic and Mediterranean.	Mediterranean. Abundant.	Male Atoll, Maldive Islands, Indian Ocean, December.	Atlantic.

	Cerasiformis Group, with Heart-shaped Gonads.		Rosacea Group with Triangular Gonads.		
	L. hyperbolica Maas 1893 = (?) L. tenuirostris L. Agassiz, 1862.	L. bicolor Eschscholtz, 1829.	L. crucifera Haeckel 1879 = L. compacta Maas, 1893, 1905 = (?) L. rosacea Eschscholtz, 1829.	L. agaricus Haeckel, 1879.	L. canariensis Haeckel, 1879.
Thickness of gelatinous substance of bell.	Thin.	Medium.	Medium.	Thin.	Thick.
Size of bell in mm.	8 to 10 wide, 3 to 8 high.	10 wide, 5 high.	40 to 50 wide, 20 high.	20 wide, 7 high.	15 to 20 wide, 8 to 10 high.
Length of peduncle in terms of bell-radius (*r*).	12 *r*	2 *r*	2.5 *r*	3 *r*	2 to 3 *r*
Shape of gonads.	Heart-shaped, or half-circles to roundish.	Wide, triangular, with rounded angles, or heart-shaped (?)	Triangular with concave sides and truncated angles. Eschscholtz's figure shows convex sides. Maas shows them concave.	3-cornered, equilateral triangle.	Semicircular, rounded, outwardly straight above.
Position of gonads.	Proximal.	Apex nearly touching bell-margin.	When mature they cover three-fourths of subumbrella lengths of radial-canals. They touch ring-canal.	Nearly touching ring-canal.	On proximal half of subumbrella.
Distance between gonads in terms of width of gonads (*b*).	1.5 *b*	*b*	*b*. Nearly touching in interradii.	*b*	*b*
Number of centripetal canals in each interradial quadrant.	3	?	7 when mature, 3 when half-grown.		3
Color.	?	Gonads with green median streak. Green stomach, lips red.	? Gonads and tentacles pink, stomach green. Lips rose-red.	?	Mouth, stomach, gonads, and canals rose-red.
Where found.	South Equatorial and Guinea Stream, Atlantic.	Coast of Brazil, Atlantic.	Tropical Atlantic, Indian, and Pacific Oceans.	New Zealand, Pacific.	Canary Islands, Atlantic.

Synopsis of the Species of Liriope.—Continued.

	Rosacea Group with Triangular Gonads.	Tetraphylla and Eurybia Groups with Oval or Egg-shaped to Circular Gonads.			
	L. lütkeni Haeckel, 1879.	L. tetraphylla Chamisso and Eysenhardt, 1821.	L. conirostris Haeckel, 1879= L. scutigera A. Agassiz, 1865.	L. eurybia Haeckel, 1864.	L. distanogona Maas, 1893.
Thickness of gelatinous substance of bell.	Fairly thick.	Thick.	Thick.	Thin.	Thick.
Size of bell in mm.	12 wide, 6 high.	15 to 30 wide, 10 high.	15 high, 10 wide.	8 to 10 wide, 3 to 5 high.	8 to 10 high, 13 to 22 wide.
Length of peduncle in terms of bell-radius (*r*).	2 *r*	3 to 4 *r*	2 *r*	2 *r*	2 *r*
Shape of gonads.	Maple-leaf shaped, five-angled. Angular appearance possibly due to preservatives.	Long, oval, egg-shaped.	Elongate, lancet-shaped, narrow. Pointed at both ends.	Oval to egg-shaped. Twice as long as wide.	Rhomboidal, with rounded edges, narrow.
Position of gonads.	In middle of radial-canals, touching base of peduncle.	Proximal, not touching margin.	From middle of radial-canals to bell-margin.	In middle of radial-canals, extending to bell-margin.	Distal.
Distance between gonads in terms of width of gonads (*b*).	One-sixth *b*.	0.5 *b*	1.5 *b* to 2 *b*	2 *b*	4 *b*
Number of centripetal canals in each interradial quadrant.	3	3	1 (or more ?).	3	3
Color.	?	Gonads with median green streak, 4 green spots on stomach.	Gonads and stomach green, lips pink.	Stomach green or milky-white. Lips red, often colorless.	?
Where found.	Azores, Atlantic Ocean.	Indian Ocean, tropical Pacific.	Florida coast, Chesapeake Bay, United States.	Mediterranean, tropical Atlantic.	South Equatorial and Guinea Stream. Atlantic.

	Tetraphylla and Eurybia Groups with Oval or Egg-shaped to Circular Gonads.				
	L. catharinensis F. Müller, 1859.	L. indica Bigelow, 1904=(?) L. hyalina Agassiz and Mayer, 1899.	L. haeckelii Goette, 1886.	L. scutigera McCrady, 1857, non L. scutigera A. Agassiz, 1865.	L. minima, Maas, 1893.
Thickness of gelatinous substance of bell.	Thick.	Medium.	Thick.	Thick.	Thin.
Size of bell in mm.	5 to 12 wide, 3 to 9 high.	14 wide, 9 high.	12 wide, 6 high.	15 to 18 wide, 12 to 15 high.	2 to 3 wide, 1 to 2 high.
Length of peduncle in terms of bell-radius (*r*).	*r*	*r*	2 *r*	2.25 *r*	4 to 6 *r*
Shape of gonads.	Egg-shaped or elliptical.	Shield-shaped, bluntly-pointed above and below.	Shield-shaped small, without sharp angles.	Narrow, oval when young; large, nearly circular, when mature.	Large, double ovals on either side of each radial-canal.
Position of gonads.	In distal parts of radial-canal, well removed from bell-margin.	On nearly whole subumbrella parts of radial-canals, but not touching peduncle or ring-canal.	In middle of radial-canals.	Near middle of radial-canals, extending from base of peduncle to near bell-margin.	Upon middle of radial-canals.
Distance between gonads in terms of width of gonads (*b*).	*b*	2 *b*	*b*+	One-fourth to one-sixth *b*.	One-fourth to one-sixth *b*.
Number of centripetal canals in each interradial quadrant.	3	1 small.	3	3	3
Color.	? Stomach and tentacles pale-red or green.	Gonads opaque-yellow. Interradial tentacles with reddish-brown nematocyst-knobs.	?	Tentacles pink, stomach green, lips rose-red and green.	?
Where found.	Coast of Brazil to Cape Cod, Massachusetts.	Suvadiva Atoll, Maldive Islands, Indian Ocean. January.	Coast of Zanzibar, East Africa.	Atlantic coast of North America, south of Cape Cod.	Atlantic Ocean, South Equatorial, and Guinea Stream.

Plate 50.

Figs. 1 and 2. Young *Liriope*, probably *L. catharinensis*. Figure 1, side view, figure 2, oral view. San Salvador Island, Bahamas, January 15; 1893.

Fig. 3. Young *Liriope*, possibly *L. catharinensis*. This medusa is older than that shown in figure 1. Banes Harbor, Cuba, February 15, 1893.

Figs. 4 and 5. *Liriope catharinensis*. Figure 5, mouth of the same medusa, retracted. Agassiz Laboratory, Newport, Rhode Island, August, 1892.

Fig. 6. *Liriope catharinensis*. With gonads of several shapes upon the several radial-canals. St. Marys River, Maryland, October 26, 1904.

Fig. 7. *Liriope scutigera*. Tortugas, Florida, July, 1898.

Figs. 8, 9, and 10. *Liriope scutigera*. Ovary, stomach, and perradial tentacle of the medusa shown in figure 7.

Fig. 11. *Aglaura hemistoma*. Oral view showing the sequence of lithocyst-clubs and tentacles. This is an oral view of the medusa shown in figure 3, plate 49. (See page 398.)

Drawn from life, by the author.

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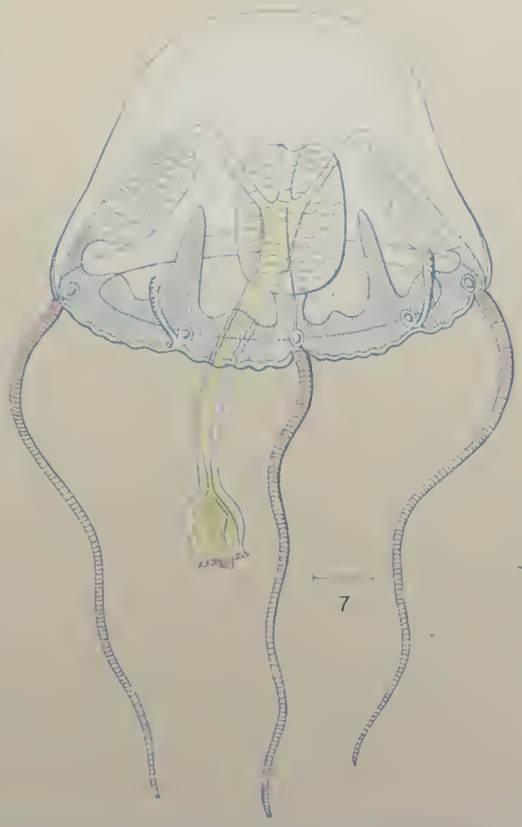

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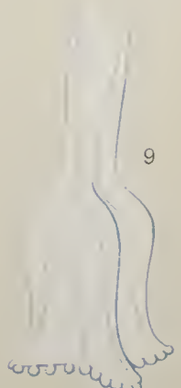

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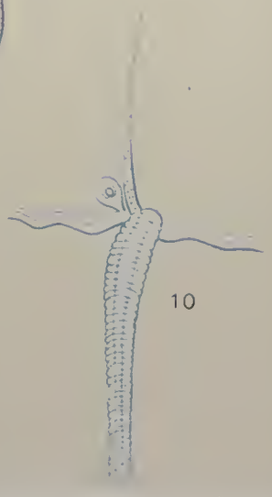

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Other forms may be conveniently grouped about these five types and classified as varieties. As Vanhöffen himself states, however, this system is not wholly satisfactory, for the gonads are themselves variable and change in shape from egg-shaped-triangular to heart-shaped as growth proceeds and the groups merge one into the other. For example, I have seen specimens of *Liriope catharinensis* with both maple-leaf-shaped and elliptical gonads in one and the same individual. Color, size, and number of tentacles are worthless as specific distinctions.

Liriope minima appears to be the smallest and *L. rosacea* the largest species, but it should be borne in mind that size in medusæ is largely influenced by the food-supply and that the same species of medusa may attain to maturity when small or when of large size, dependent upon its success in obtaining food.

Liriope exigua.

Plate 52, figs. 2 to 4; plate 53, fig. 4?

Dianæa exigua, Quoy et Gaimard, 1827, Annal. des Sci. Nat. Zool., tome 10, planche 6, figs. 5-8.—Oken, 1828, *Ibid.*, p. 342, taf. 5, fign. 5-8.
Geryonia exigua, Eschscholtz, 1829, Syst. der Acal., p. 89.
Liriope exigua, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257.
Liriope cerasiformis, Lesson, 1843, Zooph. Acalèphes, p. 332.—Haeckel, 1879, Syst. der Medusen, p. 289.—Maas, 1891, Sitz. Ber. Akad. Wissen. Berlin, p. 336.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 35, taf. 2, fign. 5, 6; taf. 3, fign. 1-3, 8-10.
Liriope scutigera, Fewkes, 1881, Bull. Mus. Comp. Zool. at Harvard College, vol. 8, No. 8, p. 162, plate 6, figs. 7, 10, 11.
(?) *Liriope mucronata*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257, taf. 8, fig. 17 (young stage of *L. exigua?*).
(?) *Glossocodon mucronatum*, Hertwig, O., und R., 1878, Nervensyst. Sinnesorgane Medusen.
(?) *Liriope cerasus*. Haeckel, 1879, Syst. der Medusen, p. 289, plate 18, fig. 15.
Geryonia appendiculata, Forbes, 1848, British Naked-eyed Medusæ, p. 36, plate 5, figs. 2-2*h*.
Liriope appendiculata, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257.
Liriantha appendiculata, Haeckel, 1879, Syst. der Medusen, p. 287.—Browne, 1896, Proc. Zool. Soc. London, p. 495 (stages in growth).
(?) *Geryonia bicolor*, Eschscholtz, 1829, Syst. der Acal., p. 89, taf. 11, fig. 1.

For description of the varieties or races of *L. exigua*, see synoptic table of the species of *Liriope*. The peduncle in this form is about as long as the bell-diameter and ranges from being narrow and nearly cylindrical to having a wide flaring base and narrow, slightly tapering conical sides.

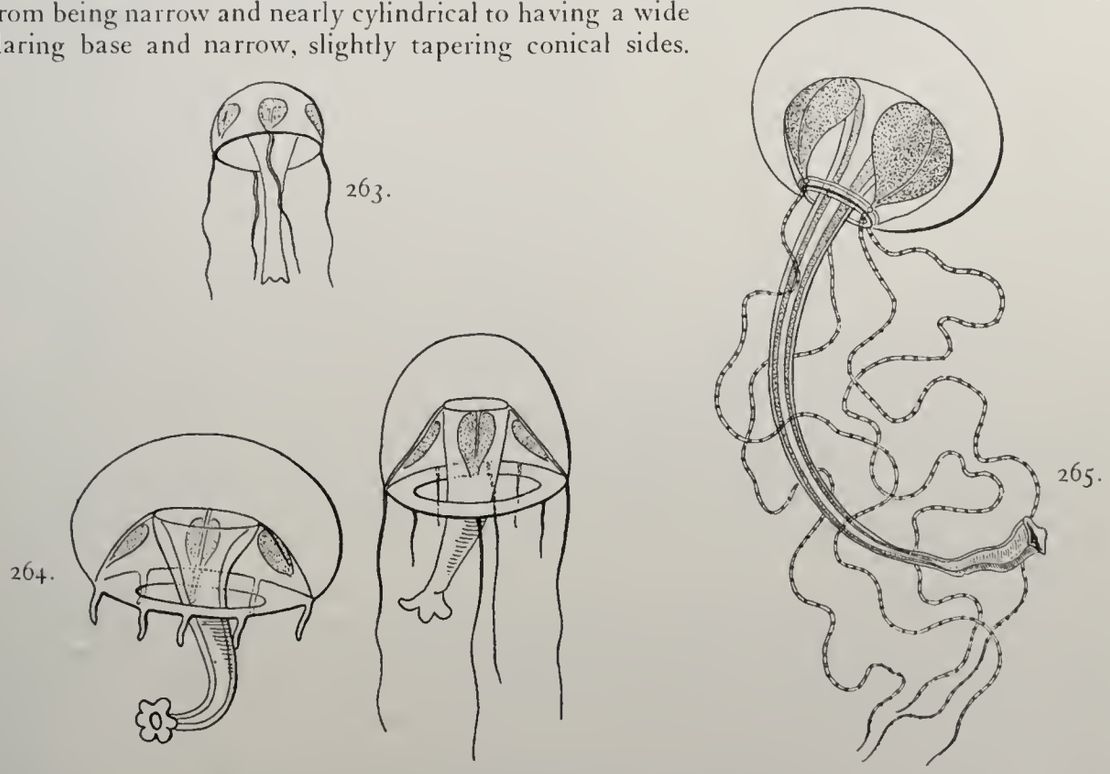


Fig. 263.—"*Liriope bicolor*," after Eschscholtz, 1829=*L. exigua*.
Fig. 264.—"*Liriope appendiculata*," after Forbes, 1848=*L. exigua*.
Fig. 265.—"*Liriope cerasus*," after Haeckel, in Syst. der Medusen=*L. exigua*.

The tropical Atlantic specimens have a more or less regularly tapering conical peduncle, whereas those of the Mediterranean have a peduncle with a widely flaring base and only

slightly tapering, almost cylindrical, lower part. Moreover, the Atlantic specimens have highly colored green or pink gonads and stomach, whereas the Mediterranean variety is usually colorless. We may conveniently follow Gegenbaur, 1856, and call the Mediterranean form *mucronata*, whereas the Atlantic variety may be called *exigua* Quoy and Gaimard = *Cerasiformis* Lesson. In Kingston Harbor, Jamaica, during March, 1909, I found a medusa which I can not distinguish from the typical *L. mucronata* which I have often seen at Naples, Italy.

Liriope mucronata Gegenbaur = a variety of L. exigua.

Liriope mucronata, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257, taf. 8, fig. 17.—Keferstein und Ehlers, 1861, Zoolog. Beitrag., p. 92, taf. 14, fign. 5, 6.—Metschnikoff, E., 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 36 (segmentation), 92 (development of the larval medusa), taf. 5, fign. 2–25; taf. 6, fign. 1–3.
Eurybiopsis anisostyla, Gegenbaur, *Ibid.*, p. 247, taf. 8, fig. 12 (larva).
Liriantha mucronata, Haeckel, 1879, Syst. der Medusen, p. 288.

The characters of the Mediterranean medusa are given in the synoptic table showing the distinctions between the various species of *Liriope*. The development of *Liriope mucronata* has been studied by Metschnikoff, 1886. The egg is 0.135 mm. in diameter and is laid between 3 and 4 in the afternoon in December to March in the Mediterranean. It is expelled from the mouth of the parent medusa and is surrounded by a mucilaginous envelope. The ectoplasm of the egg appears granular, while the endoplasm is "vacuolated" or foam-like. Segmentation is total and equal, so that at the 16-cell stage we have a small central segmentation cavity surrounded by cells, all of equal size. These 16 cells then divide transversely, thus giving rise to 16 inner cells with foam-like protoplasm which are destined to form the entoderm, while the 16 granular superficial cells form the ectoderm. The entoderm is thus formed by delamination. These entoderm cells migrate slightly inward and form a single-layered, closed sac, which is itself inclosed within the single-layered superficial sac of the ectoderm cells. A transparent jelly, the gelatinous substance of the future medusa, is secreted between the superficial ectoderm and the deep-lying sac of entoderm. The central cavity inclosed by the entoderm cells becomes the gastrocœle. The ectodermal cells become ciliated and the larva swims actively about.

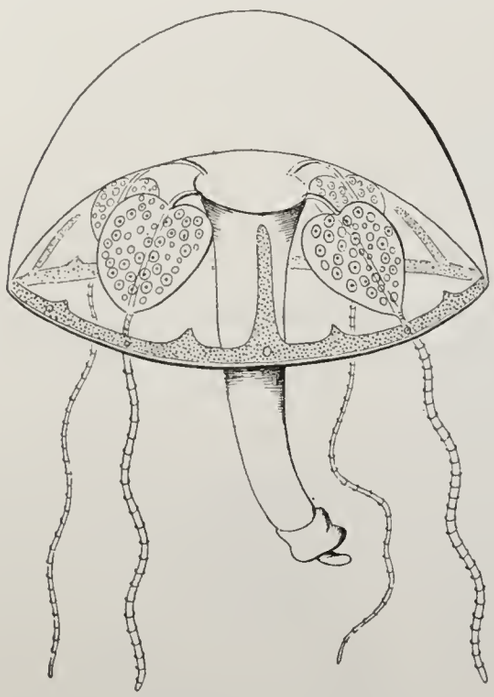


Fig. 266.—"*Liriope cerasiformis*," after Maas, in Ergeb. Plankton Expedition = *L. exigua*.

The gelatinous substance increases in thickness and the ectodermal cells become distended excepting at one pole where the gelatinous substance does not form, and finally the inner sac of the entoderm touches the ectoderm of this thin-walled pole and at the end of the fifth day we have the entoderm closely applied to the ectoderm at that which is to be the oral pole. These closely applied layers consist of columnar cells, while the superficial ectoderm of other parts of the spherical larva becomes a thin, flat, pavement epithelium.

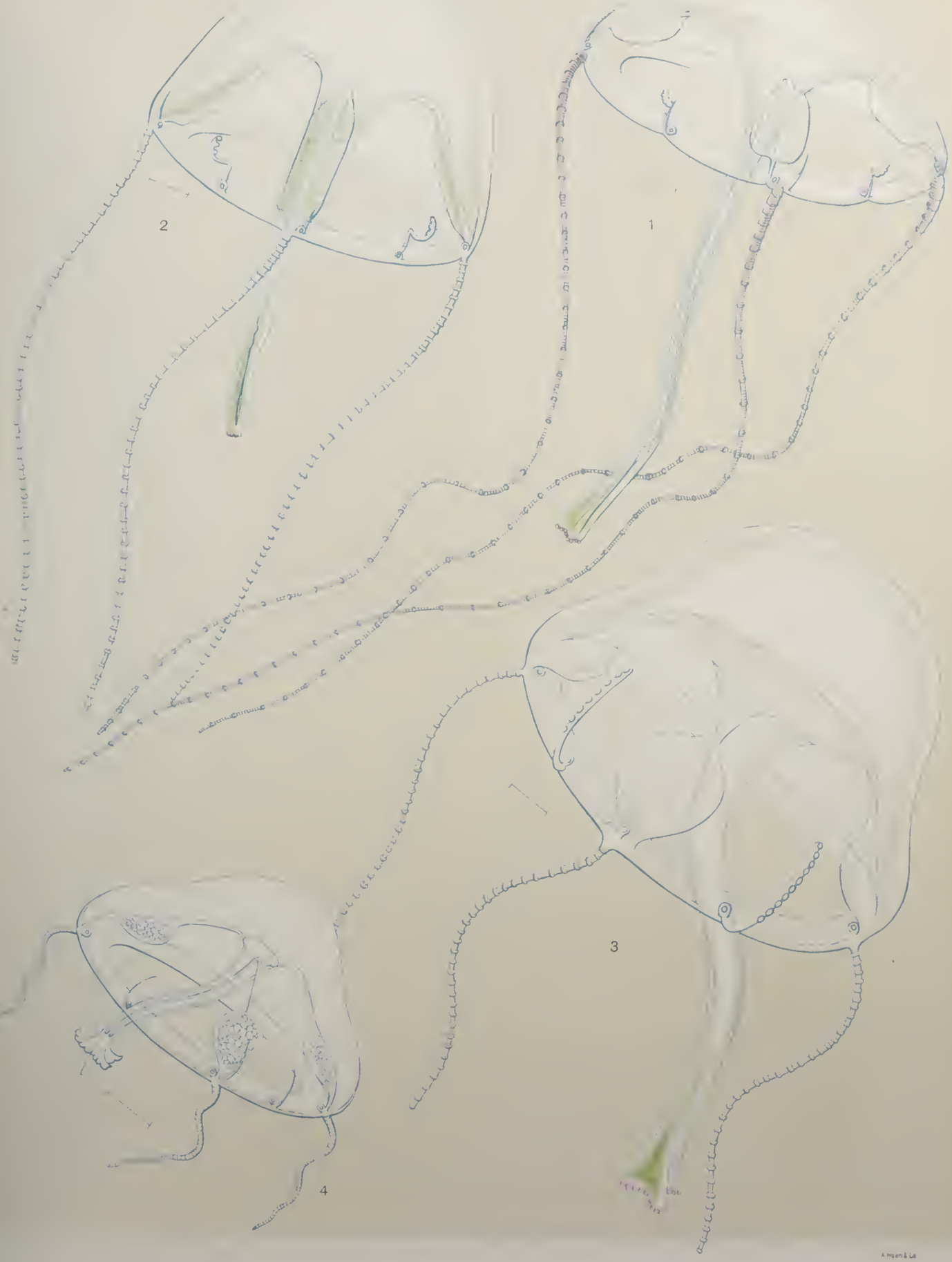
The mouth breaks through at the oral pole and 4 short, solid, nematocyst-bearing tentacles grow out from the edge of the primary stomach, their entodermal cores being formed from cells of the stomach-wall. This may be considered to be an actinula stage. The velum grows out as a diaphragm-like wall from the ectoderm, so that at the beginning of the sixth day the characters peculiar to the medusa make their appearance.

Later stages in the development of *Liriope* have been studied by Brooks in American forms. The almost spherical larval medusa flattens and the originally protrusive, lower stomach-wall becomes turned inward and a bell-cavity thus develops. The upper and lower stomach-walls fuse at 4 interradial places, the fused areas alternating with the 4 original tentacles. The 4 radial-canals and the ring-canal are simply regions where no fusion of

PLATE 51.

Fig. 1. *Liriope scutigera.* Tortugas, Florida, April 19, 1906.
Fig. 2. *Liriope conirostris.* Hampton Roads, Virginia, November 1, 1904.
Fig. 3. *Liriope eurybia.* Tortugas, Florida, June 13, 1897.
Fig. 4. *Liriope eurybia*, mature female. Nassau Harbor, Bahamas, July, 1903.

Drawn from life, by the author.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stomach-walls has taken place. The growth of the bell-walls causes the 4 original, solid, radially placed tentacles to project from the sides of the exumbrella above the margin and they usually break off and are lost. Before the loss of the 4 primary tentacles, however, 4 hollow, marginal tentacles grow out in the radii of the 4 radial-canals and 4 solid interradial tentacles develop. The medusa thus develops 12 tentacles, only 8 of which are commonly retained until maturity, although some individuals retain their 4 primary, radial tentacles

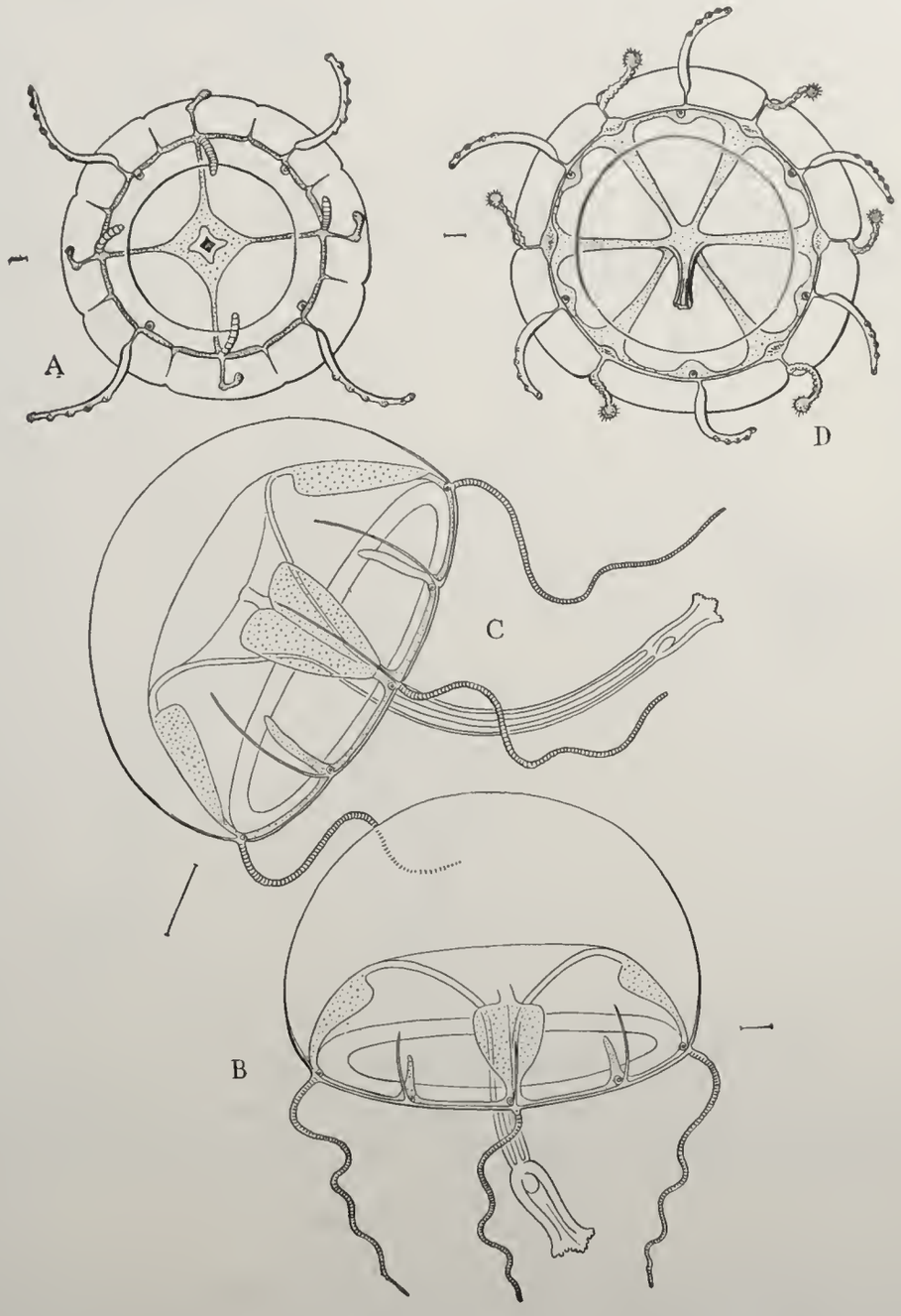
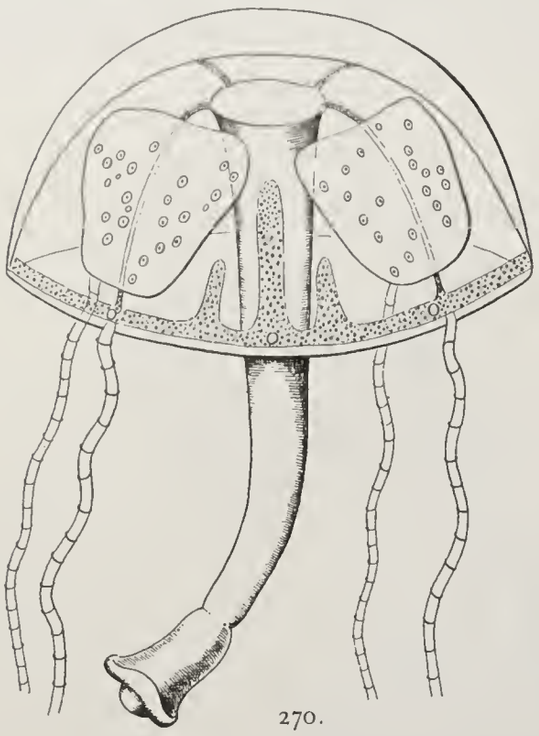


Fig. 267.—A, B, C, *Liriope mucronata*, showing successive stages in growth of medusa from 2 to 10 mm. in diameter. D, Young *Geryonia proboscidalis*, 3 mm. in diameter. From life, by the author, Zoological Station, Naples, December, 1907.

until they are half-grown medusæ. To recapitulate, these 12 tentacles are: 4 original, solid, exumbral, radially placed tentacles + 4 secondary, hollow, marginal, radial tentacles + 4 solid, marginal, interradial tentacles. Mature medusæ are often found with only the 4 hollow, radial tentacles remaining, the 8 others having been cast off.

Liriope mucronata is the common *Liriope* of the Mediterranean, being abundant throughout the year at Naples. It is usually colorless. The peduncle flares widely at its base, but is very narrow and only slightly tapering in the greater part of its length. The elongate, heart-shaped gonads are slightly narrower than the spaces between them. The measurements



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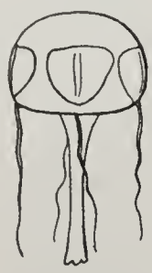

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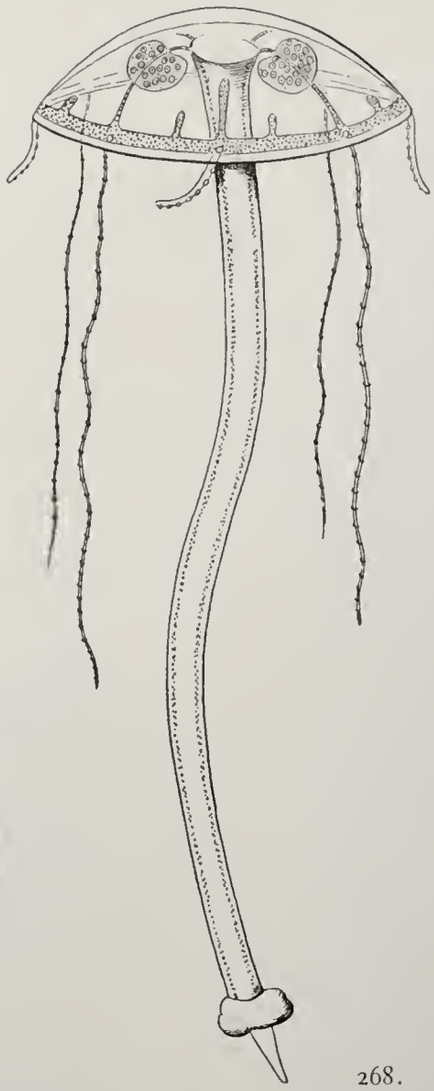

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FIG. 268.—*Liriope hyperbolica*, after Maas, in Ergeb. Plankton Expedition.
FIG. 269.—*Liriope rosacea*, after Eschscholtz.
FIG. 270.—*Liriope "compacta,"* after Maas, in Ergeb. Plankton Exped. = *L. rosacea.*

(in millimeters) of a mature medusa from Naples are as follows: Bell, 9.6 wide, 5.5 high; peduncle, 10.2 long; stomach, 2.5 long; gonads, 3 long, 2.5 wide; spaces between gonads, 4. There were only 4 interradial centripetal vessels.

Liriope hyperbolica Maas.

(?) *Liriope tenuirostris*, AGASSIZ, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 365.
Non Glossocodon tenuirostris, FEWKES, 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 11, No. 3, plate 5, figs. 4–7.—AGASSIZ, A., 1888, Bull. Mus. Comp. Zool. at Harvard College, vol. 14, p. 186, figs. 94, 96.—MAYER, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 65, plate 24, figs. 75–78.
Liriope hyperbolica, MAAS, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 38, taf. 2, fig. 4.

Agassiz, 1862, gives a very brief and vague description of a medusa from the Florida Reef, merely stating that its peduncle is longer than that of any other species of the genus. It will never be possible to determine the identity of Agassiz's species, but it bears a close resemblance to *Liriope hyperbolica* Maas. For description see the synoptic table of the species of *Liriope*.

PLATE 52.

Fig. 1. *Liriope rosacea*, mature male. Tortugas, Florida, June 4, 1906.

Fig. 2. *Liriope (exigua) "cerasiformis,"* green male. In the Gulf Stream off Cat Cay, Bahamas, April 29, 1907.

Fig. 3. *Liriope exigua.* Tortugas, Florida, June 4, 1906.

Fig. 4. *Liriope exigua.* Manubrium of the medusa shown in figure 4, plate 53, showing the interradial longitudinal muscle-strands.

Fig. 5. *Ægina rhodina.* Mastic Point, Andros Island, Bahamas, June 20, 1903. (See page 452.)

Drawn from life, by the author.

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Liriope rosacea Gegenbaur.

Plate 52, fig. 1.

(?) *Geryonia tetraphylla*, Chamisso et Eysenhardt, 1821, Nova Acta Phys. Med., Acad. Leop. Carol., tome 10, p. 357, fig.
Geryonia rosacea, Eschscholtz, 1829, Syst. der Acal., p. 89, taf. 11, fig. 2.
Liriope rosacea, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257.—von Lendenfeld, 1885, Proc. Linnean Soc. New South Wales, vol. 10, p. 241.—Maas, 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 26, taf. 3, fign. 7, 8.
Liriope rosacea+*L. crucifera*, Haeckel, 1879, Syst. der Medusen, p. 290.
Liriope compacta, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 37, taf. 3, fig. 11.
Liriope compacta (mature medusa), Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 61, 62, taf. 9, fign. 55–59.
Liriope sp., Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 38, taf. 4, fign. 3 to 6.

When fully grown the bell is 40 to 50 mm. wide, slightly flatter than a hemisphere, with fairly thick, gelatinous substance; it is evenly rounded without an apical projection. The 4 hollow, radial tentacles are about twice as long as bell-diameter. There are 7 blindly ending centripetal canals in each quadrant. The peduncle is about half as wide as the bell itself at its base and tapers gradually to a narrow, distal apex at stomach. It is 1.25 to 1.5 times as long as bell-diameter. The gonads are developed upon the outer, subumbrella parts of the radial-canals near ring-canal. When fully developed they extend along three-quarters or more of the subumbrella lengths of the radial-canals from the ring-canal toward the base of the peduncle. At first the gonads are equilateral and triangular with a bluntly rounded angle touching the ring-canal, but later the sides extend out in a ring-like manner so as to touch in

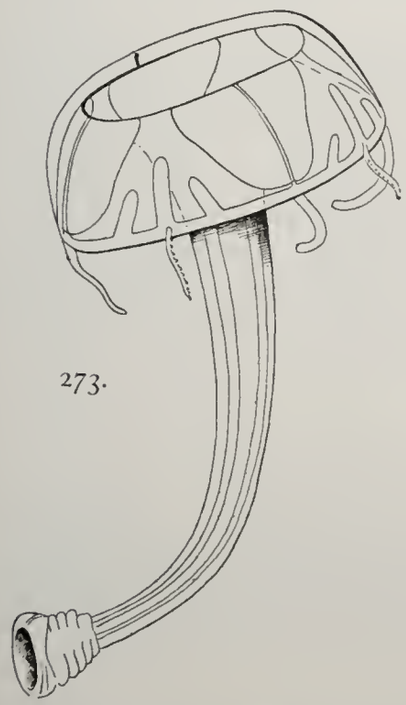

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Fig. 273.—*Liriope tetraphylla*, after Vanhöffen, in deutsch. Tiefsee Expedition, *Valdivia*.
Fig. 273*a*.—*Liriope tetraphylla*, after Chamisso and Eysenhardt, 1821, Nova Acta Phys. Med. Nat. Curios., tome 10.

the 4 interradii (see Maas, 1905, taf. 9, fign. 55, 57). Each gonad is then a broad, wide triangle with concave lateral sides and with the upper (centripetal) side bowed outward on both sides of the middle line, with all of the angles "cut off," or bluntly rounded.

In Tortugas specimens the entoderm of the gonads and tentacles is pink, the stomach green, and the lips rose-red.

This form is described by Maas from the coast of Brazil near the equator and I have taken it occasionally at Tortugas, Florida. In 1905 Maas gives an excellent series of figures of specimens of this medusa from the Malay Archipelago, and these make it all but certain that *L. rosacea* Eschscholtz, and *L. crucifera* Haeckel, from the Pacific and Indian Oceans, are only young and half-grown stages of *L. compacta* Maas, 1905 (see text-figure 271). The medusa should therefore be known by its oldest ascertainable name: *L. rosacea* Eschscholtz. It is evidently of world-wide distribution in tropical oceans and is the largest known species of *Liriope* when mature. *L. tetraphylla* is probably only another name for a growth-phase of this medusa.

The numerous examples found by the *Siboga* in the Malay Archipelago have enabled Maas to study the growth-stages of this medusa in detail. When the medusa is 18 mm. wide the gonads are 4 large triangles on the distal ends of the 4 radial-canals, but there are only 3 wide centripetal canals in each quadrant. This stage is shown in my figure of a specimen from Tortugas, Florida. Later, when the angles of the triangular gonads become blunted and they are about to touch in the 4 interradii of the subumbrella, 4 small, new diverticula develop from the ring-canal between the 3 original diverticula, thus giving 7 centripetal canals in each interradial quadrant. The first of these new diverticula develop on both sides of the original, large, interradial diverticulum, and then the centripetal diverticula close by the sides of the radial-canals begin to develop. The medusa is most abundant from June to September, both in the Malay Archipelago and at Tortugas, Florida.

Liriope tetraphylla Gegenbaur.

Plate 53, fig. 4?

Geryonia tetraphylla, Chamisso et Eysenhardt, 1821, Nova Acta Phys. Med. Acad. Leop. Carol., tome 10, p. 357, plate 27, fig. 2.—Eschscholtz, 1829, Syst. der Acalephen, p. 88.

Liriope tetraphylla, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 257.— Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, p. 82, taf. 10, fig. 14.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipel., vol. 2, p. 738, plate 54, fig. 3; 1905, Report Pearl Oyster Fisheries, Gulf of Manaar, Royal Soc. London, Suppl. Report No. 27, p. 152.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 61.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 112.

Xanthea tetraphylla, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 365.

Liriantha tetraphylla, Haeckel, 1879, Syst. der Medusen, p. 286.

This "species" is the oldest known *Liriope*. It appears to be quite common in the Pacific and Indian Oceans. It is distinguished by its long, cylindrical peduncle with a conical base. Peduncle 3 to 4 times as long as bell-radius. The gonads are upon the proximal half of the subumbrella and are egg-shaped, not touching the ring-canal. The medusa appears to range from about 15 to 30 mm. in width and is hemispherical, with thick, gelatinous walls. See synoptic table of *Liriope*. *L. rosacea* is, I believe, only another name for this medusa, for I sometimes find intergrading specimens at Tortugas, Florida (see plate 53, fig. 4), which appear to have the characters of *L. exigua*, *L. rosacea*, and *L. tetraphylla* in varying proportions of definiteness. I am more and more inclined to believe that all "species" with triangular or heart-shaped gonads should be called *L. tetraphylla*, and this medusa is found in all warm oceans. (See text-figure 273.)

Liriope agaricus Vanhöffen.

Glossocodon agaricus, Haeckel, 1879, Syst. der Medusen, p. 293.

Liriope agaricus, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 79.

See synoptic table of species of *Liriope*.

This form is distinguished by its triangular, equilateral gonads on the outer halves of the subumbrella lengths of the radial-canals, touching the ring-canal. Peduncle cylindrical with a conical base and is about 3 times as long as bell-radius. 7 centripetal canals in each interradial quadrant, 3 long and 4 short. Bell about 20 mm. wide. Coast of New Zealand. This is probably identical with *L. tetraphylla*.

Liriope canariensis Vanhöffen.

Glossoconus canariensis, Haeckel, 1879, Syst. der Medusen, p. 292.

Liriope canariensis, Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 79.

See synoptic table of species of *Liriope*.

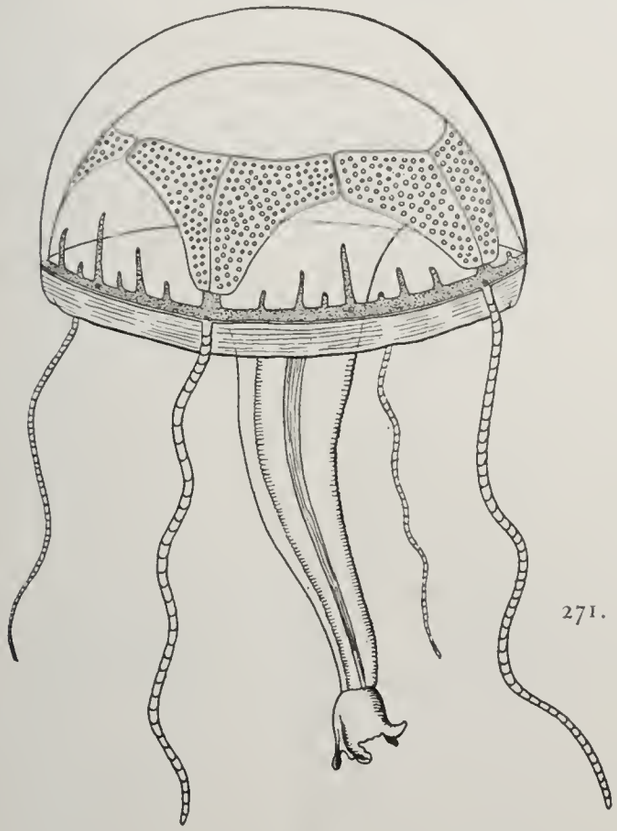
This form is distinguished by its semicircular gonads on the proximal half of the subumbrella touching the base of the peduncle and widely separated from the ring-canal. Peduncle cylindrical, with conical base, and 2 to 3 times as long as bell-radius. There are 3 centripetal vessels in each quadrant, the middle (interradial) ones being longer than the adradial. The mouth, gonads, stomach, and canals are rose-red. Found by Haeckel at the Canary Islands, in February.

Liriope lütkenii.

Glossocodon lütkenii, Haeckel, 1879, Syst. der Medusen, p. 293, taf. 18, fig. 5.

Bell hemispherical, 12 mm. in diameter. There are 4 very long, slender, radially situated tentacles, fully twice as long as bell-diameter. No interradial tentacles were seen in the

specimen described by Haeckel. There are 8 small, inclosed lithocysts, 4 radial and 4 interradial, each with a single spherical concretion. Velum well developed. The peduncle is about as long as bell-diameter and tapers gradually. There is a long, pointed tongue in the throat. There are 4 lips. The 4 radial-canals are wide and smooth-edged and the circular vessel gives rise to 12 blindly ending centripetal vessels, 3 in each quadrant. These are all of equal length, but the interradial vessel of each quadrant is straight, while the ends of the two vessels flanking it bend inward toward the interradial vessel. The 4 gonads are wide and maple-leaf-shaped. This species was described by Haeckel from preserved specimens found in the



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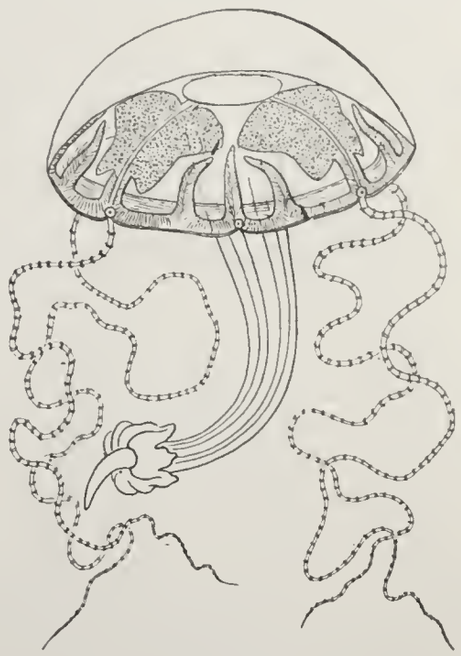

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Fig. 271.—*Liriope "compacta,"* after Maas in Ergeb. *Siboga* Exped., Monog. 10.
Fig. 272.—*Liriope "lütkenii,"* after Haeckel.

neighborhood of the Azores and further westward between 30° to 40° N. lat., and 15° to 45° W. long. It seems not improbable that the very remarkable angles shown by Haeckel in the gonads may be due to contraction caused by the preservative fluids. Haeckel is the only naturalist who has seen this medusa, and I believe it is actually *L. tetraphylla.*

Liriope conirostris Haeckel.

Plate 51, fig. 2.

Liriope scutigera, Agassiz, A., 1865, North American Acal., p. 60, fig. 87.
Non Liriope scutigera, McCrady, 1857, Gymn. Charleston Harbor, p. 106.
Liriope conirostris, Haeckel, 1879, Syst. der Medusen, p. 291.

See synoptic table of species of *Liriope.*

This species is distinguished by its narrow, elongate, shield-shaped gonads, pointed at both ends. The space beween the gonads is considerably wider than the width of the gonads themselves. The gonads are situated upon the outer halves of the subumbrella lengths of the radial-canals and their outer points touch the ring-canal. Peduncle also characteristic, very narrow, conical, and about as long as bell-diameter; apparently only one short centripetal vessel in each quadrant. Bell about 15 mm. wide, higher than a hemisphere, thick-walled. Gonads and stomach green, lips pink. Found from Chesapeake Bay to the coast of Florida, United States.

Liriope eurybia Haeckel.

Plate 51, figs. 3 and 4.

Geryonia exigua, Leuckart, 1856, Archiv. für Naturges., Jahrg. 22, p. 3, taf. 1, fig. 1.
Liriope eurybia, Haeckel, 1864, Jena. Zeit. für Naturw., Bd. 1, pp. 329, 462, taf. 12, fign. 11–25.—Spagnolini, 1871, Atti della Soc. Ital. di Sci. Nat., vol. 14, fasc. 3, p. 31.—Haeckel, 1879, Syst. der Medusen, p. 291.—Maas, 1891, Sitzungsber. Akad. Wissen. Berlin, p. 336; 1893, Ergeb. der Plankton Exped., Bd. 3, K. c., p. 35, taf. 2, fign. 2, 3; 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 26.
Liriope ligurina, Haeckel, 1864, Jena. Zeit. für Naturw., Bd. 1, p. 457; 1865, Familie der Geryoniden, p. 23.
Glossocodon eurybia, Haeckel, 1866, Jena. Zeit. für Naturw., Bd. 2, pp. 93–128, 129–143.

See synoptic table of species of *Liriope*.

Distinguished by its thin-walled bell, flatter than a hemisphere. Peduncle not quite as long as bell-diameter, cylindrical with conical base. Gonads egg-shaped, twice as long as

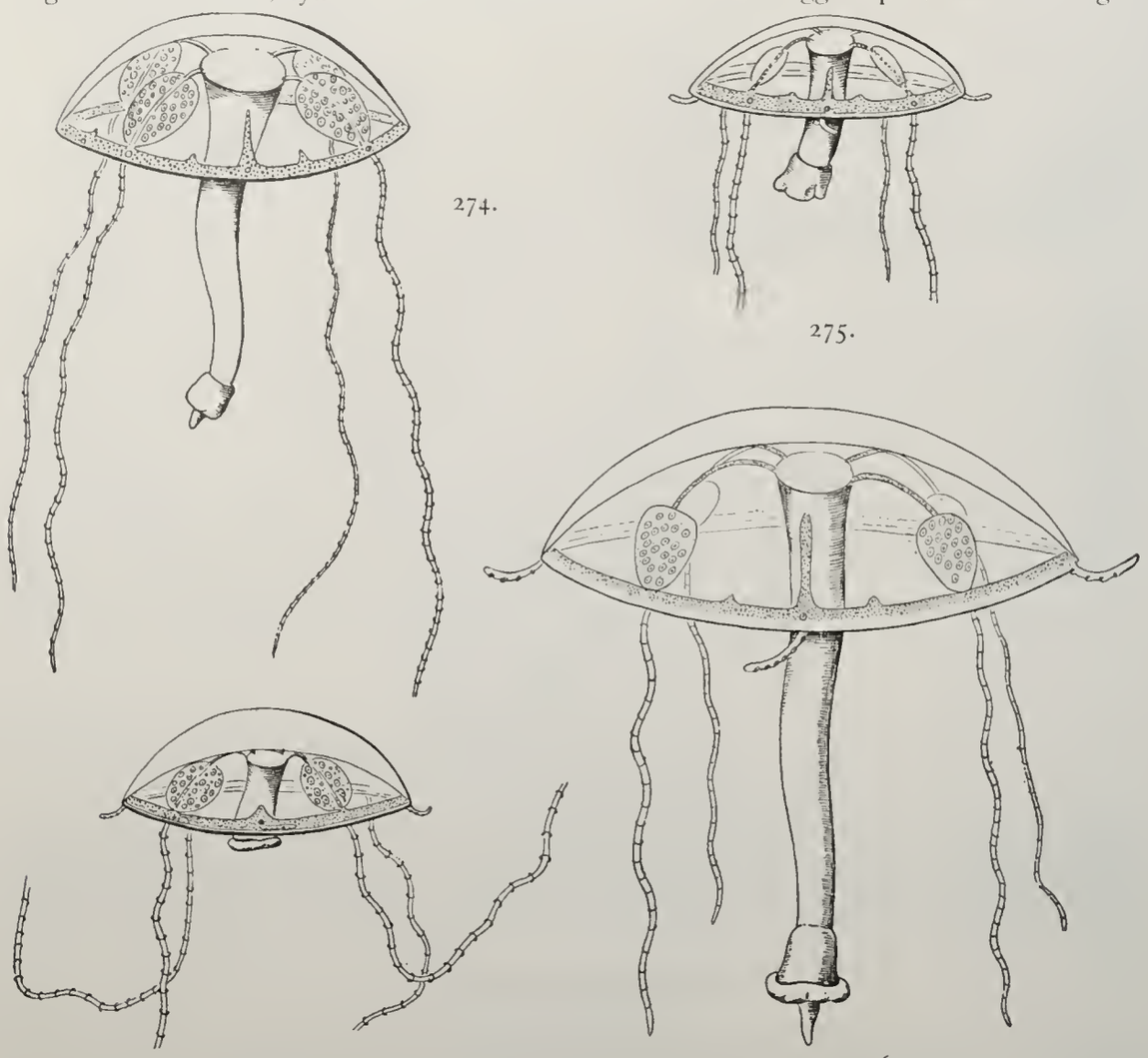


Fig. 274.—*Liriope eurybia.*
Fig. 275.—*Liriope eurybia* (young).
Fig. 276.—*Liriope distanogona.*
Fig. 277.—*Liriope catharinensis.*
Above figures after Maas, in Ergeb. Plankton Expedition.

wide, their outer ends touching ring-canal. 3 interradial, centripetal vessels in each quadrant. Gonads and stomach green, milky-white, or colorless. Found in the Mediterranean. Common.

Liriope distanogona Maas.

Liriope distanogona, Maas, 1893, Ergeb. Plankton Expedition, Bd. 2, K. c., p. 36, taf. 3, fign. 4–7.

See synoptic table of species of *Liriope*.

Distinguished by its *narrow* rhomboidal gonads with rounded edges. The gonads are on the outer parts of the radial-canals. The spaces between the gonads are twice as wide as are

the gonads themselves. There are 3 centripetal canals in each interradial quadrant. South Equatorial and Guinea Stream, Atlantic Ocean.

Liriope catharinensis F. Müller.

Plate 50, figs. 1 to 6.

Liriope catharinensis, Müller, F., 1859, Archiv. für Naturges., Jahrg. 25, Bd. 1, pp. 310, 316, taf. 11, 25 fign.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 365.—Maas, 1893, Ergebnisse der Plankton Expedition, Bd. 2, K. c., p. 37, taf. 2, fign. 7, 9.
Glossocodon catharinensis, Haeckel, 1864, Jena. Zeitsch. für Naturw., Bd. 1, p. 461; 1864, Familie der Rüsselquallen, p. 27.
Liriantha catharinensis, Haeckel, 1879, Syst. der Medusen, p. 287.

Medusa is bell-shaped, thick walled, 6 to 12 mm. in diameter, and 4 to 9 mm. in height. There are 4 radially situated, hollow tentacles, each somewhat longer than bell-diameter. The 4 interradial, solid tentacles are very short. The peduncle is narrow, cylindrical, with a trumpet-shaped, flaring base, and is about half as long as the bell-diameter. Stomach short, with 4 simple, nematocyst-studded lips, and with a short, pointed tongue in the throat. There are 4 radial-canals and 3 short, interradial, centripetal vessels in each quadrant. The 4 gonads are leaf-like, usually elliptical or egg-shaped, and do not quite extend to bell-margin, though developed upon the outer, subumbrella lengths of the 4 radial-canals. Stomach, mouth, and tentacles pale-green or red. (See text-figure 277.)

This form is found off the coast of Brazil at Santa Catharina Island, where it was discovered and described by Fritz Müller. The Plankton Expedition found it in abundance off the Brazilian coast from the mouth of the Amazon southward. It is exceedingly common in Chesapeake Bay and Pamlico Sound in the autumn, thriving well in the brackish waters of numerous estuaries along the southern Atlantic coast of the United States. In August it is drifted by southerly winds upon the southern coast of New England. I found it at Jamaica, West Indies, in March, 1909.

The gonads are usually oval or elliptical, but vary greatly in shape. The specimen here figured had 2 egg-shaped, 1 elliptical, and 1 "maple-leaf-shaped" gonads.

Maas, 1893, finds that this medusa may become sexually mature while still retaining all 12 of its tentacles. Usually, however, the 4 hollow, secondary, radial, and the 4 solid, interradial tentacles are all that remain, the original, 4 solid, radial ones having disappeared in early life.

Liriope indica Bigelow.

Liriope indica, Bigelow, H. B., 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 258, plate 5, figs. 17, 18.
Liriope hyalina (immature?), Agassiz and Mayer, 1899, *Ibid.*, vol. 32, p. 166, plate 9, fig. 32.

See synoptic table of the species of *Liriope*.

This form is distinguished by its shield-shaped gonads, pointed at both ends. The gonads are upon the middle three-fourths of the subumbrella lengths of the radial-canals, not touching the ring-canal or the base of the peduncle. The peduncle is cylindrical and about as long as the bell-radius. Indian Ocean, open parts of the tropical Pacific. (See text-figure 279.)

Liriope haeckelii.

Glossocodon haeckelii, Goette, 1886, Sitzungsber. Akad. Wissenschaft. zu Berlin, Jahrg. 1886, p. 833.

This form resembles *L. lütkenii* Haeckel, but the gonads are shield-shaped, or widely band-like, without reentrant angles and angular points. The distance between the gonads is greater than their own width. There are 3 centripetal canals in each quadrant, the middle one being much wider and longer than the 2 beside it. Coast of Zanzibar, East Africa.

Liriope scutigera McCrady.

Plate 50, figs. 7 to 10; plate 51, fig. 1.

Liriope scutigera, McCrady, 1857, Gymn. Charleston Harbor, p. 106.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 365.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, No. 12, pp. 275, 383, plates 41, 42.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 36, taf. 2, fig. 1.
Xanthea scutigera, Haeckel, 1864, Geryoniden, p. 24. Also: *Liriantha scutigera*, 1879, Syst. der Medusen, p. 287.
Glossocodon tenuirostris, Fewkes, 1882, Bull. Mus. Comp. Zool. at Harvard College, vol. 9, No. 7, p. 278, plate 7, figs. 1–9; 1884, Mem. Mus. Comp. Zool. at Harvard College, vol. 11, No. 3, figs. 4–7, plate 5.—Agassiz, A., 1888, Bull. Mus. Comp. Zool. at Harvard College, vol. 14, p. 186, figs. 94, 96.—Hargitt, 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 57, 1 fig.—Mayer, 1900, Bull. Museum Comp. Zool. at Harvard College, vol. 37, p. 65, plate 24, figs. 75–78.

Umbrella bell-shaped, about 1.5 times as broad as high, about 15 mm. in diameter, the sides flanged. There are 4 long, hollow, radially situated tentacles covered with rings of nematocysts. These radial tentacles are very flexible and two or three times as long as diameter of umbrella. There are also 4 short, stiff, solid, interradial tentacles that are curled sharply upward. These small tentacles are armed with groups of nematocyst-cells upon their outer (peripheral) sides. These small tentacles are easily broken off and are occasionally wanting in mature individuals. There are 8 lithocysts, each containing a single, spherical concretion. 4 of these are situated near the bases of the radial tentacles and 4 at bases of the interradial tentacles. Velum well developed. The circular canal has not more than one short interradial

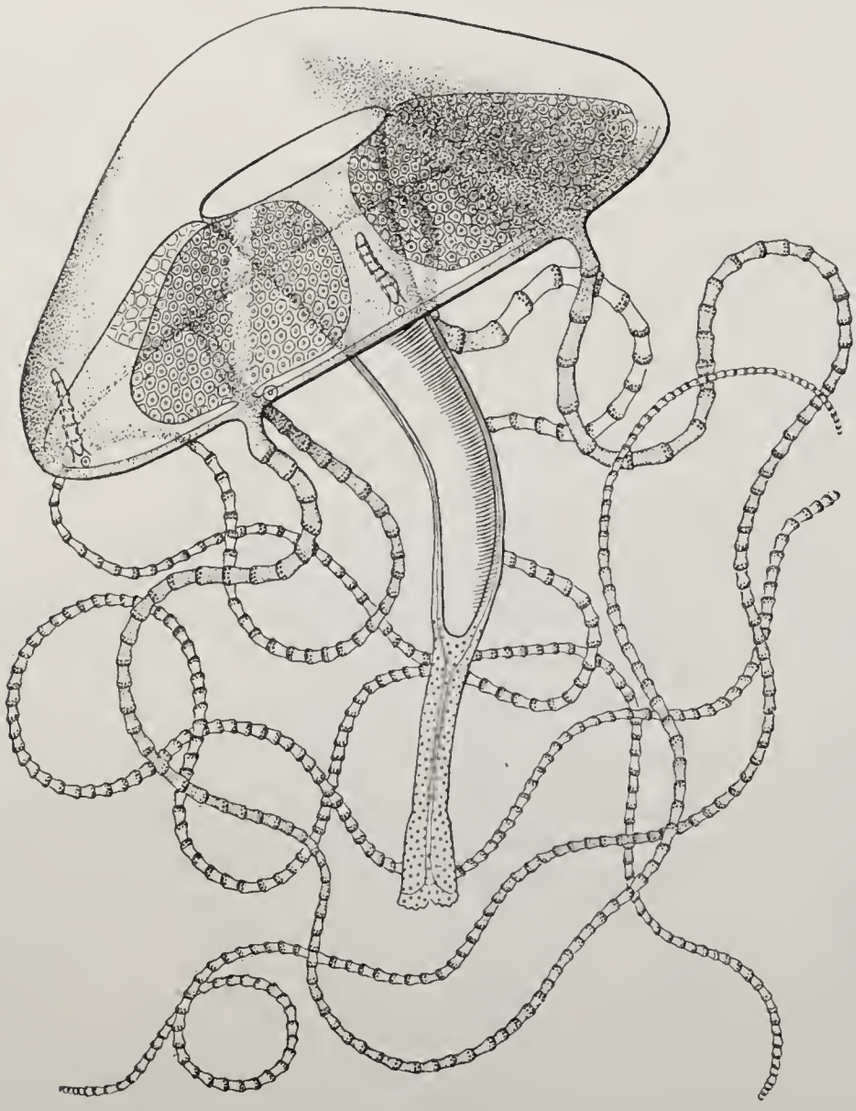


FIG. 278.—*Liriope scutigera*, after Brooks, in Mem. Boston Soc. Nat. Hist., 1886.

diverticulum in each quadrant. There are 4 radial tubes, upon which the 4 gonads are developed. Gonads, nearly square to circular with rounded corners, extend from near the circular vessel to inner apex of subumbrella; in old individuals they nearly meet along the interradii. Peduncle thick and conical above, slender and prismatic below, usually a little longer than diameter of bell. Mouth quadrate, with a tongue-like, gelatinous process within gastric portion that may sometimes be protruded beyond the mouth.

The body of the medusa is so very hyaline that it is difficult to discover its presence in the water. The lips are often of a delicate emerald-green and their nematocyst-cells are tinged with a delicate purple.

PLATE 53.

Fig. 1. *Geryonia proboscidalis*, young, immature medusa. Tortugas, Florida, May 25, 1906.

Fig. 2. *Geryonia proboscidalis*. Manubrium of the medusa shown in figure 1, with lips drawn backward revealing the "tongue."

Fig. 3. *Geryonia proboscidalis*, half-grown medusa. Tortugas, Florida, July 11, 1907.

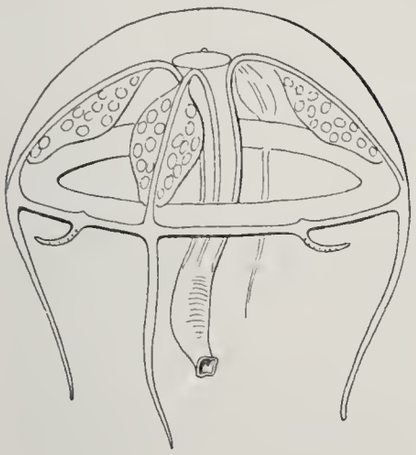
Fig. 4. *Liriope exigua* (?), *tetraphylla* (?) Tortugas, Florida, July 4, 1907.

Drawn from life, by the author.

Armen & Co

This medusa is common at the Tortugas Islands, Florida, and in the Bahamas. It is most abundant, however, in Charleston Harbor, South Carolina; a few battered specimens have been found at Newport, Rhode Island, late in the summer.

Brooks, 1886, gives an excellent figure of the mature medusa and a detailed account of its development from the egg. The development is direct. A delamination gastrula is formed



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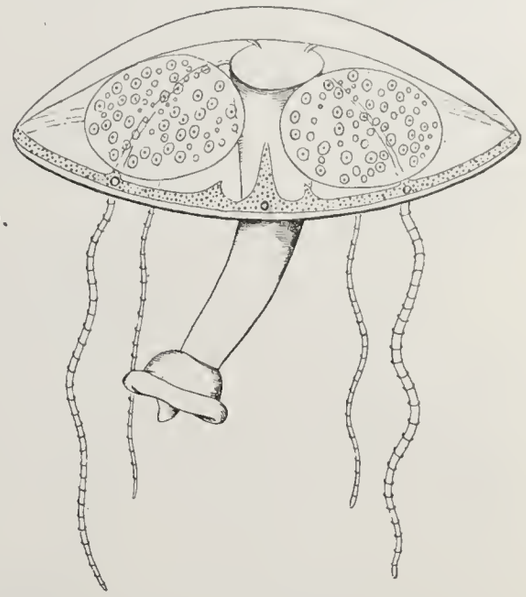


280.

Fig. 279.—*Liriope indica*, after Bigelow, in Bull. Museum Comp. Zool. at Harvard College.
Fig. 280.—*Liriope scutigera*, after Maas, in Ergeb Plankton Expedition.

and this develops into a free hydra that possesses a gelatinous umbrella. The free hydra becomes converted into a medusa by the pushing inward of the peristome to form the subumbrella. The young medusa has 8 solid tentacles, 4 radial and 4 interradial. The 4 original, radial tentacles usually disappear, however, and are replaced by the 4 long, hollow, flexible, secondary tentacles that characterize the adult.

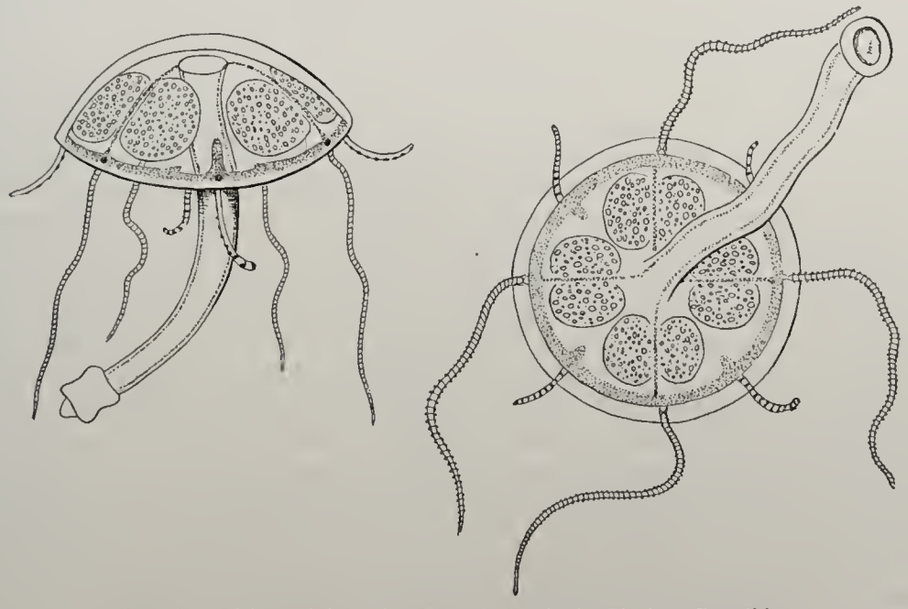


Fig. 281.—*Liriope minima*, after Maas, in Ergeb. der Plankton Expedition.
Side and oral views of mature medusa.

Liriope scutigera McCrady is specifically distinct from "*Liriope scutigera*" of A. Agassiz, 1865, p. 60, fig. 87, and also from "*Liriope scutigera*" Fewkes, 1881 (Bull. Museum Comp. Zool. at Harvard College, vol. 8, p. 162, figs. 7, 10, plate 6).

Liriope minima Maas.

Liriope minima, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 37, taf. 2, fign. 8, 10; taf. 4, fign. 1, 2.

See synoptic table of species of *Liriope*.

This tropical Atlantic form appears to be the smallest known *Liriope*, becoming mature when only 2 to 3 mm. wide. The gonads are large, double ovals on either side of the middle of each radial-canal. The peduncle is 4 to 6 times as long as the bell-radius. The space between the gonads is only one-fourth to one-sixth as wide as each gonad itself. This form may possibly be a starved medusa which has become sexually mature. (See fig. 281.)

Genus GERYONIA Péron and Lesueur, 1809.

Geryonia (in part), Péron and Lesueur, 1809, Annal. du Mus. d'Hist. Nat., tome 14, p. 329.—Eschscholtz, 1829, Syst. der Acal., p. 86.

Geryonia, Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 8.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 254.—Fol, 1873, Jena. Zeitschrift für Naturwissen., Bd. 7, p. 472.—Metschnikoff, 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 247; Embryol. Studien an Medusen, Wien, pp. 23, 59, 91.—Maas, 1893, Ergeb. der Plankton Expedition, K. c., Bd. 2, pp. 28, 31, 39.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, *Valdivia*, Bd. 3, Lfg. 1, p. 85.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 116.

Leuckartia, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 364.

Geryones + Geryonia + Carmaris + Carmarina, Haeckel, 1879, Syst. der Medusen, pp. 293, 294, 296, 297.

The type species is *Geryonia proboscidalis* of tropical seas first described by Forskål, 1775, under the name *Medusa proboscidalis*. This medusa is probably identical with *Geryonia dianea*, *Carmarina hastata*, *C. fungiformis*, and *C. hexaphylla* of Haeckel, 1879. *Carmaris giltschii* Haeckel is probably the same medusa with its gonads crumpled through excessive contraction in the preservative fluid.

GENERIC CHARACTERS.

6-rayed Geryonidæ with 6 radial-canals, 6 lips, 6 gonads, and 12 inclosed lithocysts. There are 6 solid, primitive temporary radial, 6 hollow, permanent, secondary radial, and 6 solid, interradial tentacles. Interradial centripetal canals appear to be always present. Development is direct.

Haeckel, 1879, defines four genera as follows:

Geryones, without blind centripetal canals, with 12 tentacles;
Geryonia, without blind centripetal canals, with 6 tentacles;
Carmaris, with blind, interradial centripetal canals, with 12 tentacles;
Carmarina, with blind, interradial centripetal canals, with 6 tentacles.

Metschnikoff, 1886, Maas, 1893, and Vanhöffen, 1902, have shown that blind centripetal canals appear to be always present, and one can not separate genera upon the possession of 6 or 12 tentacles, for a study of the development shows that the first tentacles to appear upon the actinula larva are 6 solid, radial ones, these followed by 6 solid, interradial, and finally by 6 hollow, radial tentacles. The 6 primitive, radial tentacles are soon lost and the interradial tentacles may or may not be lost; so that mature medusæ of one and the same species may have 12 (6 hollow radial and 6 solid interradial) or only 6 radial tentacles. (See fig. 267.)

It is evident from the above that Haeckel's new genera *Geryones*, *Carmaris*, and *Carmarina*, represent nothing in nature and must be abolished. Haeckel lays much stress upon the presence or absence of a "tongue" in the stomach in distinguishing species, but this varies greatly in size and as was shown by Metschnikoff, 1886, is of no specific value.

The development of *Geryonia* has been studied by Fol, 1873, and Metschnikoff, 1886. It is direct, and is essentially similar to that of *Liriope*, excepting that the medusa is 6-rayed. The entoderm is formed by delamination from the inner ends of the cells of the blastula in the 16-cell stage as in *Liriope*. 6 primary, radial tentacles and 6 interradial entodermal fusions are formed instead of 4 as in *Liriope*.

Geryonia is common in the Mediterranean, and has been made the subject of some interesting physiological experiments. Krukenberg, 1880, studied the reactions to curare and strychnine. Nagel, 1893, 94, found that the tentacles only are sensitive to chemical stimuli, but that they do not react in lukewarm water. Sanzo, 1903, and Bethe, 1903, 08, 09, studied the phenomenon of inhibition, and reaction to salts, in the rhythmical pulsation. Schneider, 1891, studied the histology of the nematocyst-cells.

Geryonia is the host of the parasitic larvæ of *Cunina*, and as such has been made the special study of Metschnikoff, Maas, Woltereck, Stschelkanowzeff, and others.

Geryonia proboscidalis Eschscholtz.

Plate 53, figs. 1 to 3; plate 54, fig. 10.

Medusa proboscidalis, Forskål, 1775, Descript. animalium Hauniæ, p. 108; Icon., tab. 36, fig. 1.
Dianæa proboscidalis, Delle Chiaje, 1822, Mem. Anim. senza Vert., Regno Napoli, tav. 73, fig. 9.
Geryonia proboscidalis, Eschscholtz, 1829, Syst. der Acalephen, p. 88.—Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 8, taf. 1, fig. 3.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 254, taf. 8, fig. 16.—Noshin, 1865, Mélang. biolog. St. Pétersbourg, tome 5, p. 28, plate 1 (development).—Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 247; 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 59 (formation of entoderm), 91 (development of larva and medusa), taf. 6, fign. 4–12.—Vanhöffen, 1902, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer *Valdivia*, Bd. 3, Lfg. 1, pp. 84, 85, taf. 10, fig. 15.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 116.
Geryonia hexaphylla, Brandt, 1838, Mém. Acad. Sci. St. Pétersbourg, p. 389, taf. 18.—Schulze, 1875, Mittheil. Naturw. Vereins für Steiermark, p. 1, taf. 1.—Maas, 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 26, taf. 3, fig. 6.
Liriope proboscidalis, Lesson, 1843, Hist. Zooph. Acal., p. 331.
Geryonia proboscidalis + Leuckartia proboscidalis, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 364.
Geryonia hastata, Haeckel, 1864, Jena. Zeitsch. fur Naturw., Bd. 1, p. 467, taf. 11; Bd. 2, p. 143, taf. 5, 6.
Geryonia fungiformis, Fol, 1873, Jena. Zeitsch. für Naturwissen., Bd. 7, p. 472, taf. 24, 25 (development).
Geryonia proboscidalis + G. dianæa + (?) Carmaris umbella + Carmaris giltschii + Carmarina hastata + C. fungiformis + C. hexaphylla, Haeckel, 1879, Syst. der Medusen, pp. 295–298, taf. 18, fig. 8.
Carmarina hastata, Krukenberg, 1880, Vergleichend. physiolog. Studien zu Tunis, Mentone und Palermo, Abth. 3, p. 124, etc. (reactions to curare and strychnine).—Sanzo, 1903, Archiv. Italiennes de Biologie, tome 39, p. 318 (the process of inhibition in the rhythmical pulsation).—Bethe, 1903, Allgemeine Anat. und Physiol. Nervensyst., pp. 411, 414, 415, 419, etc., fig. 83*c*; 1908, Pflüger's Archiv., Bd. 124, p. 451; *Ibid.*, 1909, Bd. 127, p. 219 (laws of pulsation).—Maas, 1908, Verhardl. deutsch. Zool. gesell, p. 116 (experimental embryology).
Geryonia (*Carmarina*) *fungiformis*, Metschnikoff, E., 1881, Zeit. für wissen. Zool., Bd. 36, p. 433, taf. 28, fig. 1–4 (development).
Carmarina hastata, Schneider, 1891, Zool. Anzeiger, Bd. 14, p. 379 (histology of nettle-cells); 1892, Jena. Zeit. für Naturwissen., Bd. 20, p. 423, taf. 14, fign. 21–39, 42–48 (histology of nervous system, nematocysts, etc.)—Nagel, 1893, Archiv. für Physiol. Pflüger, Bd. 54, p. 165 (reactions to chemical stimuli). *Ibid.*, 1894, Bd. 57, p. 495.—Davidoff and Garijev, 1907, Bericht Zool. Station, Villa Franca, 47, p. 12.
Geryonia mexicana + Carmaris rosea (young medusæ), Agassiz, A., and Mayer, 1902, Mem. Museum Comp. Zool. at Harvard College, vol. 26, p. 149, plate 4, figs. 17, 18.
Geryonia (*Carmarina*) *hastata*, Stschelkanowzeff, 1906, Mitth. Zool. Sta. Neapel, Bd. 17, p. 479 (two sorts of Cunina larvæ infest *Geryonia*).

Adult medusa.—The bell is nearly hemispherical, with moderately thick walls, and is 35 to 80 mm. in diameter. There are 6 long, hollow, contractile, radial, and 6 short, solid, interradial tentacles. The long tentacles are in the radii of the 6 radial-canals and are highly contractile and provided with rings of nematocysts. The short, interradial tentacles project from the sides of the bell at a short distance above the margin and are studded along their aboral sides with wart-like clusters of nematocysts. These interradial tentacles are very stiff and brittle and are often lost, leaving only the 6 long, radial tentacles. There are 12 inclosed lithocysts above the velum near the bases of the 12 tentacles. Each lithocyst contains a single spherical concretion. There are well-developed circular muscles in the subumbrella.

There are 6 radial-canals and typically 6×7 straight, blindly ending centripetal vessels which arise from the wide circular vessel. In each interradial sextant the interradial centripetal vessel is longest, the 2 adradial ones being not quite so long, and the 4 intermediate ones being much shorter.

The solid, gelatinous peduncle is conical to trumpet-shaped, about as long as the bell-diameter and as wide at its base as is the bell-radius. It tapers to a narrow end outwardly. Well-developed, longitudinal muscles extend down the interradial sides of the peduncle and enable it to bend from side to side, or to contract to a considerable degree. These muscles of the peduncle extend also along both sides of each of the 6 radial-canals from the region of the gonads to the base of the peduncle. On the peduncle itself they form 6 broad bands, extending down each interradius between the sides of the radial-canals. The same arrangement of muscle fibers is seen in *Liriope*, excepting that in *Geryonia* there are 6 and in *Liriope* only 4 interradial muscle-bands.

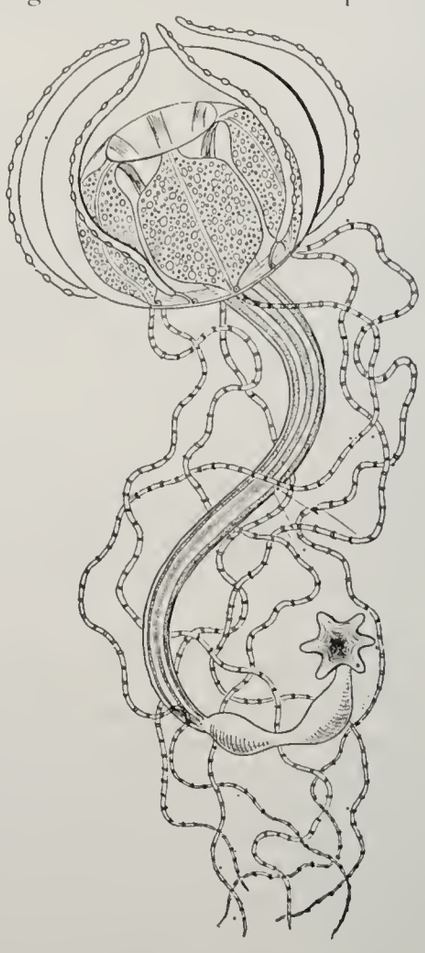
The stomach is short with 6 simple lips and a more or less well-developed tongue-shaped projection is usually to be seen in the throat; but this is very variable in its development. The 6 gonads are elongate and more or less heart-shaped and extend over the subumbrella from near the base of the peduncle to points about midway between base of peduncle and ring-canal. When mature the sides of adjacent gonads nearly touch one the other.

Gonads usually rose-pink, but occasionally dull yellowish-white or colorless. Stomach and entodermal cores of tentacles usually pink, but occasionally dull-white or colorless.

This medusa is widely distributed, being found in the tropical parts of the Atlantic, Pacific, and Indian Oceans, and in the Mediterranean. It is not seen in impure harbors, but is a creature of the surface of the open sea far from coasts, being independent of land for its developmental stages.

The development has been studied in detail by Fol, 1873, and Metschnikoff, 1886. The egg is 0. 23 to 0.33 mm. in diameter and is laid at mid-day during April in the Mediterranean. The segmentation is total and equal, and the entoderm is formed by delamination from the inner ends of the cells of the blastula at the 16-cell stage. The details of development are,

282.



283.

Fig. 282.—*Geryonia proboscidalis*, mature medusa, showing muscular system. From life, by the author, Zoological Station, Naples, December 3, 1907.

Fig. 283.—*Geryonia "elephas,"* after Haeckel, in Syst. der Medusen.

indeed, quite similar to those of *Liriope*, excepting that there are 6 primary tentacles instead of 4, as in *Liriope*, and there are also 6 interradial fusions of the walls of the primary stomach-cavity. (See text-fig. 267.)

This medusa is far more abundant and grows to a greater size in the Mediterranean than in other parts of the world. Specimens from Florida and the Bahamas are nearly always pink in color, whereas the Mediterranean medusæ are colorless, milky, or brownish-yellow. One rarely sees the American medusa more than 50 mm. in diameter, whereas in the Mediterranean specimens 75 mm. wide are abundant.

Bethe, 1903, 08, 09, finds that if the medusa be paralyzed by removal of its bell-margin, NaCl is a local stimulant and will revive temporary pulsations. On the other hand Mg inhibits pulsation. The medusa displays a refractory period similar to that observed by Marey, 1876, in the vertebrate heart. It can not be stimulated when in systole at normal temperatures. The effects of the ions of the salts of sea-water are essentially the same in both *Geryonia* and *Rhizostoma*.

Nagel, 1893, 94, states that in *Geryonia* the ectoderm of the subumbrella and the manubrium is insensitive to chemical, but very sensitive to mechanical, stimulation; whereas the tentacles are more sensitive to chemical than to mechanical stimuli. The mouth is extended so as to touch any part of the bell-margin which may be stimulated, thus behaving in a manner similar to that found to be the case by Romanes in his "*Tiaropsis indicans.*"

Stschelkanowzeff, 1906, finds that, in the Mediterranean, *Geryonia proboscidalis* is the host of the parasitic larvæ of two species of *Cunina*, *C. proboscidea* and *C. rhododactyla.*

Mass, 1908 (Verhandl. deutsch. Zool. Gesell., p. 114), gives the results of some important observations and experiments upon the development and structure of the egg in *Geryonia* and *Liriope.* In *Geryonia* three distinct regions can be recognized in the unfertilized egg: an inner mass of gelatinous material, surrounded by a coarsely foam-like cytoplasm, and a peripheral layer of fine structure. The polar coordination of the larva is not determined in the 2-layered stage wherein the larva consists of ectoderm and entoderm, but is determined by the polarity of the unfertilized egg itself. Mass finds in accord with Zoja that the isolated blastomeres of the 2-cell stage each develop into perfect medusæ. The 4 blastomeres of the 4-cell stage give a larva with a closed entodermal sac, with differentiated entoderm on its subumbrella side but no mouth-opening. The 8 and 16-cell blastomeres resemble even more closely the planula condition in the most advanced stage of development to which they are capable of attaining. Unfortunately, this important paper has appeared too late to be adequately reviewed here and should be consulted in the original.

Geryonia "elephas."

Geryones elephas, Haeckel, 1879, Syst. der Medusen, p. 294, taf. 18, fig. 7.

Bell globular, fuller than a hemisphere, 50 mm. wide, 40 mm. high. This medusa is said to be distinguished from *G. proboscidalis* by its long, narrow, *cylindrical* peduncle, apparently 3 times as long as the bell-diameter, instead of being about the same length, as in *G. proboscidalis.* Moreover, the gonads are much wider than in *G. proboscidalis* and are 6-sided, nearly touching, covering almost the entire area of subumbrella. The gonads extend along the 6 radial-canals from base of peduncle to ring-canal. No centripetal canals (?) Found off the coast of South Africa (Indian Ocean?).

Described by Haeckel from a preserved specimen. I am inclined to suspect that this so-called species may be a specimen of *G. proboscidalis* with its bell unnaturally contracted through the influence of preservative reagents. (See text-fig. 283.)

Order NARCOMEDUSÆ Haeckel, 1879.

Æginidæ, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 259.
Thalassantheæ, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 167.
Narcomedusæ, Haeckel, 1879, Syst. der Medusen, p. 299.—Maas, 1897, Mem. Museum Comp. Zool. at Harvard College, vol. 23, p. 27; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 64; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 496.—Vanhöffen, 1907, Zool. Anzeiger, Bd. 32, p. 175; 1908, Wissen. Ergeb. deutsch. Tiefsee Exped., Bd. 19, Heft 2.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 47.

CHARACTERS OF THE ORDER NARCOMEDUSÆ.

Veiled medusæ with marginal sensory-clubs containing concretions of entodermal origin and with bell-margin cleft into lappets. The web-like velum bridges over these clefts between the lappets and also projects as a diaphragm beyond their outer margins, in such manner as to form an annulus which partially closes the opening of the bell-cavity.

There are free sensory-clubs, with entodermal concretions upon the margins of the lappets. These sensory-clubs arise from pad-like, bristle-bearing ectodermal thickenings, and a bristle-bearing tract of ectodermal cells may or may not extend up the sides of the exumbrella above each sensory-club. Haeckel calls these tracts "otoporpæ."

The tentacles project stiffly from the sides of the bell at the upper ends of the clefts between the lappets. A strand of ectoderm, called the peronium, extends along the groove of each cleft to the ventral side of the base of the tentacle, where it becomes thickened, forming a cushion-like pad beneath the tentacle and serving apparently for its support. The tentacles are always solid, with their entodermal cores composed of a single, axial row of disk-like, chordate, vacuolated cells. These axial cores of the tentacles are sheathed in ectoderm and penetrate inward through the gelatinous substance of the bell to the margin of the central stomach. Indeed the axial-core of each tentacle is continuous with the entoderm of the margin of the stomach, while its ectoderm is continuous with that of the exumbrella. The tentacles often bear bristles, especially near their tips, where they are usually quite conspicuous in young medusæ. A single row of nematocyst-capsules often extends along the abaxial line of each tentacle.

The central stomach is a lenticular space, bounded outwardly by the insertions of the tentacles. The subumbrella floor of the stomach is usually quite flat, although occasionally it is conical. The mouth is usually a simple, round opening, although in a few species there are 4 lips and an elongate throat-tube. The margin of the stomach may be simple and circular, or it may display peripheral pouches, due, in *Cunoctantha* at least, to interradial fusions of the stomach walls dividing the originally circular stomach-cavity into spoke-like outpocketings. Saccules in the intertentacular radii may also project in the form of pouches from the subumbrella floor of the stomach. In forms having saccules or pouches projecting downward from the subumbrella floor of the stomach we find that the central cavity of each sac is filled by a projecting plug of gelatinous substance which extends downward from the aboral wall of the stomach.

A marginal ring-canal system may or may not be present and is often variable in its development even in different individuals of one and the same species. When present the ring-canal system consists in a loop around the margin of each lappet and thus the ring-canal is separated into as many loops as there are lappets. Each loop bends between two adjacent pairs of tentacles, extending outward from the stomach-cavity along one side of a tentacle down along the same side of the peronium of this tentacle and upward along the side of the adjacent peronium and its tentacle into the central stomach-cavity of the medusa.

The gonads are developed in the ectoderm of the subumbrella under the central stomach or upon its subumbrella pouches. The gonad may be ring-like or more or less isolated upon separated stomach-pouches. The ring-muscles of the velum and subumbrella are very powerful and swimming is accomplished mainly through their action.

The development has been studied by J. Müller, Gegenbaur, McCrady, F. Müller, F. E. Schulze, Metschnikoff, H. V. Wilson, Korotneff, Maas, Brooks, Woltereck, Stschelkanowzeff, H. B. Bigelow, and others. In some cases, as in *Solmundella*, the egg develops into an actinula larva and this becomes directly transformed into a medusa by the outgrowth of the bell from the sides of the body between the tentacles. The tentacles of the actinula become those of the medusa and the bell grows outward between and beyond the tentacles so that we can not assert that the tentacles have migrated upward from the bell-margin, for the bell has actually

grown downward from the bases of the tentacles, which retain their primitive position. Haeckel's assumption that the tentacles have secondarily migrated upward is not borne out by the embryological evidence and appears to me to be untrue. I believe the bell in Narcomedusæ to be merely a newly-formed, collar-like expansion of the side walls of the actinula, and not comparable with the bell of Anthomedusæ. While this book has been in press Goette, 1907 (Zeit. für wissen. Zool., Bd. 87, p. 289), has presented an able exposition of the view I here advocate.

We should then regard the Narcomedusæ as medusiform actinulæ, and not as being directly comparable with the Anthomedusæ and Leptomedusæ, which arise by budding from hydroids and in which the tentacles grow out from the bell-margin *after* the bell has been formed. The entodermal sensory-clubs of Narcomedusæ can not be considered to be homologous with the ectodermal lithocysts of the Leptomedusæ, but are evidently modified tentacles.

The species of *Cunina* and *Cunoctantha* exhibit very interesting parasitic stages in their development, for in their asexual generation they infest the gastrovascular spaces or gelatinous substance of other medusæ such as *Geryonia*, *Turritopsis*, etc.

Stschelkanowzeff, 1905–1906, studied the life-history of the common *Cunina proboscidea* of the Mediterranean, and the development in this case is probably typical for the more complex life-histories, such as are to be witnessed in the genus *Cunina*. In *C. proboscidea* the eggs of the free-swimming medusa develop in the ectoderm, but when mature they migrate into the entoderm and are fertilized in the stomach-wall of the mother-medusa, where they remain attached and develop rudimentary tentacles, sensory-clubs, bell and velum, but practically no gelatinous substance. The mouth breaks through, and finally the sexual products (male or female) develop in the ectoderm of the subumbrella of the young medusa, which still remains in the stomach-cavity of its mother. The daughter medusa then degenerates into a mere sac filled with genital products, which escape into the water through the mouth of the free-swimming mother-medusa. These eggs then develop into free-floating planula larvæ which attach themselves to the stomach or lips of the medusa *Geryonia*, where they grow and finally develop numerous asexually produced medusa-buds which are set free to form the large free-swimming sexual generation. There are thus three generations, one large, sexual, free-swimming; one internal, degenerate, sexual; and one free-swimming actinula-form, which reproduces asexually.

External medusa-buds are produced by budding upon the gonads of *Cunoctantha fowleri* Browne, and internal stolons are budded from the entodermal layer of *Cunina peregrina* and *Pegantha laevis* Bigelow.

Being developed from transported, free-floating or parasitic larvæ, and being independent of shore conditions for their development, the Narcomedusæ are of world-wide distribution, being in a peculiar sense creatures of the open ocean. They are common in the Mediterranean, but are quite rare elsewhere, and are all but unknown from polar regions. Most of the species are of extreme tenuity and die so rapidly in aquaria and are so difficult to study alive, that but little is known of them even to-day.

Haeckel (1879, p. 301) divides the Narcomedusæ into two suborders, Porpylotæ with "otoporpæ" at the bases of the sensory-clubs, and Cordylotæ, without these small sensory tracts. It appears inadvisable to separate suborders upon so slight a distinction and, indeed, in this case it leads to the wide separation of forms which are actually closely related. For example, Haeckel defines his four families of the Narcomedusæ as follows:

PORPYLOTÆ.

1. CUNANTHIDÆ: With perradial stomach-pouches and with a marginal ring-canal system.
2. PEGANTHIDÆ: Without radial stomach-pouches and with a marginal ring-canal system.

CORDYLOTÆ.

3. ÆGINIDÆ: With interradial stomach-pouches and with a marginal ring-canal system.
4. SOLMARIDÆ: Without ring-canal system or "festoon canal."

Later researches by H. V. Wilson, Maas, H. B. Bigelow, Vanhöffen etc., have demonstrated that some of the Cunanthidæ lack a marginal ring-canal system, while others possess it, and it is also very variable in Æginidæ, being sometimes absent and sometimes present. It therefore appears to be an unsuitable character upon which to attempt the separation of families.

The radiating stomach-pouches in Haeckel's Cunanthidæ extend outward in the radii of the tentacles and terminate *without forking* at the bases of the tentacles. In the Æginidæ, on the other hand, the stomach-pouches bifurcate and extend outward even beyond the points of insertion of the tentacles. Accordingly, we may conveniently group these two families under the name Æginidæ, distinguishing the subfamilies Cunanthinæ with simple, uncleft, radial stomach-pouches, and Ægininæ with stomach-pouches cleft by the insertions of the tentacles. Similarly we may combine the Peganthidæ and Solmaridæ of Haeckel under one family, the Solmaridæ. We may thus classify the Narcomedusæ as follows:

ORDER NARCOMEDUSÆ.

I. Family Solmaridæ: Without peripheral stomach-pouches. With or without subumbrella saccules in the floor of the subumbrella.

II. Family Æginidæ: Narcomedusæ with marginal stomach-pouches in the radii of the tentacles.

(*a*) Subfamily Cunanthinæ, with simple, uncleft stomach-pouches in the tentacular radii.

(*b*) Subfamily Ægininæ, with radial stomach-pouches cleft by the insertions of the tentacles.

In the following arrangement of genera I have, however, disregarded the subfamilies Cunanthinæ and Ægininæ and have grouped the genera of both in such a manner as to indicate their probable phylogenetic relationships. It must be borne constantly in mind, however, that our knowledge of the Narcomedusæ is still so imperfect that nothing but a provisional classification of the forms can, as yet, be attempted.

I would regard the genus *Solmaris* as the simplest anatomically, and possibly also the oldest phylogenetically of the Narcomedusæ. The following scheme may possibly illustrate the relationships of the various groups.

Genus Solmaris. With a plain, circular stomach-margin, *without* marginal pouches and *without* saccules in the subumbrella floor of the stomach.

Family Æginidæ. *With* marginal stomach-pouches, but *without* saccules in the subumbrella floor of the stomach.

Genus Pegantha. *Without* marginal stomach-pouches but *with* saccules in the subumbrella floor of the stomach.

Vanhöffen, 1907, divides the Narcomedusæ into two groups, each group having two families. He distinguishes the groups in accordance with the character of the peripheral canal-system and upon differences in development. He bases his system upon the results of his study of the collection of Narcomedusæ obtained by the German Deep-Sea Expedition. I present the scheme of classification he proposes in the Zoologischen Anzeiger, Bd. 32, p. 175, and in Die Narcomedusen der *Valdivia* Expedition, p. 71.

1. Diocheteumena. With a well-developed peripheral canal-system. Development indirect through parasitic larvæ.
   A. Æginidæ. With large stomach-pouches and peronial canals (=radial-canals joined by marginal vessels.)
      Genera: *Ægina*, with 4 to 6 tentacles; *Æginura*, with 8 tentacles; *Ægineta*, with more than 10 tentacles.
   B. Peganthidæ. With rudimentary stomach-pouches, long radial-canals and short marginal connecting vessels.
      Genera: *Pegantha*, when fully-developed, with 10 to 13 tentacles; *Polyxenia*, when fully-developed, with 16 to 18 tentacles; *Polycolpa*, when fully-developed, with 25 to 30 tentacles.
2. Adiocheteumena. With rudimentary canal-system and direct development of the medusa from the egg.
   C. Æginopsidæ. With tentacles reduced to half their original number, so that there is a peronial strand without a tentacle between every two existing tentacles.
      Genera: *Solmundella*, with 2 tentacles; *Æginopsis*, with 4 tentacles.
   D. Solmaridæ. With a tentacle in the radius of each and every peronial strand.
      Genera: *Solmundus*, with 4 tentacles; *Cunoctona*, with 7 to 8 tentacles; *Solmaris*, with 10 to 64 tentacles.

In my opinion the extreme variability of the marginal canal-system renders it unsuitable for generic distinctions, and in common with Bigelow, 1909, I thus find myself unable to advantageously apply Vanhöffen's system to the classification of the Narcomedusæ.

The system proposed by Dr. H. B. Bigelow, 1909, as a result of his important studies of Narcomedusæ from the eastern tropical Pacific is essentially similar to that which I here

adopt, excepting that he divides my Æginidæ into two families, Cunanthidæ with undivided gastric pouches equal in number to, and in the radii of, the tentacles; Æginidæ with gastric pockets commonly adradial in the adult, usually 2 to 4 times as numerous as tentacles. In *Ægina alternans*, a new form found by Bigelow, however, the gastric pockets are *interradial* and alternate with the tentacles. This may have been brought about through the obliteration of the interradial cleft between the originally adradial pockets, but the development is as yet unknown.

Family SOLMARIDÆ Haeckel, 1879, sensu Maas.

Peganthidæ+Solmaridæ, Haeckel, 1879, Syst. der Medusen, pp. 323, 346.
Solmaridæ, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 41; 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 80; 1906, Fauna Arctica, Bd. 14, Lfg. 3, p. 498.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, pp. 50, 81.

FAMILY CHARACTERS.

Narcomedusæ in which the periphery of the stomach is simple and circular without peripheral stomach-pouches. With or without saccules in the floor of the subumbrella wall of the stomach. With a variable number of tentacles, the solid entodermal cores of which are attached to the periphery of the central stomach, while the tentacles themselves project stiffly from the sides of the bell.

The bell-margin is cleft into lappets, which alternate with the tentacles, and the margins of these lappets bear sensory-clubs with concretions of entodermal origin. There may or may not be ectodermal sensory bristle-bearing tracts (otoporpæ) over the exumbrella above these sensory-clubs. The velum is a wide diaphragm and also extends upward as a web, bridging over the clefts between the lappets. The peripheral, marginal, ring-canal system is either degenerate or wanting altogether, or well developed.

The development appears to be direct, the free-floating, actinula larva being gradually transformed into the form of a medusa. Thus the ontogeny of these medusæ is widely different from that of the Anthomedusæ and Leptomedusæ, and the medusa-shape appears to have been attained in an independent manner. The Narcomedusæ may, I think, be regarded as medusiform actinulæ and the bell as a secondarily acquired organ, which does not begin to grow out until after some, at least, of the tentacles have developed upon the sides of the oral zone of the actinula. In the Anthomedusæ and Leptomedusæ, on the other hand, the bell develops *before* the tentacles and lithocysts, whereas the reverse is the case in Narcomedusæ. Thus the bells in the two groups are not homologous structures, but have been acquired independently in response to similar environmental conditions. The entodermal lithocysts of Narcomedusæ are evidently not homologous with the ectodermal lithocysts of the Anthomedusæ and Leptomedusæ, but are, phylogenetically speaking, merely modified tentacles.

The tentacles have not migrated upward from the bell-margin as is maintained by Haeckel, etc., for the development shows that the bell grows downward and outward, beyond the bases of the tentacles which simply retain their primitive position.

The Solmaridæ are very widely distributed over warm and tropical seas, but are poorly represented in the Polar Regions. The Mediterranean appears to contain the greatest number of species, whereas these forms are very rare off the tropical coasts of America.

Haeckel, 1879, states that the Solmaridæ have no ring-canal, no peronial canals, and no otoporpæ at the bases of the sensory-clubs; whereas his Peganthidæ possess these structures. Haeckel, however, cut no sections. As Maas has shown, the ring-canal system in other families of Narcomedusæ is very degenerate and subject to great variability in development, even in different individuals of one and the same species. It is, therefore, not a suitable criterion for the separation of families, and is, indeed, hardly of specific value.

The presence or absence of otoporpæ appears to me to be of too slight an importance to serve as a sole distinction between families, and Haeckel's Peganthidæ should be merged with the Solmaridæ. I would define the Solmaridæ as follows: Narcomedusæ without marginal stomach-pouches. With or without saccules in the *subumbrella floor* of the stomach.

The following is a description of the genera of *Solmaridæ:*

Solmaris = Polycolpa + Solmaris Haeckel, 1879. Without saccules on the subumbrella floor of the stomach. Gonad ring-like and developed more or less diffusely in the subumbrella floor of the stomach.

Pegantha = Pegasia + Polyxenia + Pegantha + Solmoneta (in part) Haeckel, 1879. With pouch-like saccules upon the subumbrella floor of the stomach. The genital products are found in the ectoderm of these saccules.

The generic names *Pegasia* and *Polyxenia* are older than *Pegantha*, but are so vaguely defined that I fear it would be hopeless to attempt to revive them and they may best be permitted to lapse into oblivion together with *Dianæa*, *Foveolia*, etc.

Genus SOLMARIS Haeckel, 1879, sens. emend.

Ægineta (in part), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 262.

Polycolpa (immature ?) + *Solmaris*, Haeckel, 1879, Syst. der Medusen, pp. 327, 355.

Solmaris, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 44; 1897, Mem. Mus. Comp. Zool. at Harvard College, vol. 23, p. 27; 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 80.

Synoptic Table of Species of Solmaris.

	S. leucostyla.	S. flavescens = Ægineta flavescens Gegenbaur, 1856.	S. solmaris = Ægineta solmaris Gegenbaur, 1856.*	S. corona = Ægineta corona Keferstein und Ehlers, 1861.†
Shape and size of bell in mm.	3 wide. Flat to hemispherical.	Lenticular. 23 wide, 6 thick.	Flat, lenticular, concavo-convex. 35 wide, 12 high.	About hemispherical. 15 mm. wide.
Number of tentacles and lappets.	12 to 26 tentacles. About as long as bell-diameter.	12 to 17, as long as bell-diameter.	18 to 20 tentacles, about as long as bell-diameter.	24 to 35. Tentacles 1 to 2 times as long as bell-diameter.
Shape of marginal lappets.	Quadratic. One-half as long as radius of central, lenticular part of bell.	Quadratic as in S. leucostyla.	Quadratic.	Rectangular, about twice as long as wide.
Number of sensory-clubs upon each lappet.	About 1.	Usually 2.	6 to 8	1 to 3
Character of gonads.	A wide ring of ectoderm in subumbrella under margin of stomach.	As in S. leucostyla.	A wide, smooth annulus in outer half of subumbrella wall of stomach.	A wide, smooth annulus on outer one-third to two-thirds of subumbrella wall of stomach.
Color.	Tentacles white, with yellow tips.	Tentacle tips yellowish-green, stomach dull yellow-green, lithocysts red.	Stomach, gonads, and tentacles whitish or gray.	Tentacles sometimes red or yellow. Gonads colorless or rose-colored. Lithocysts yellow-green or rose-colored.
Where found.	Mediterranean.	Mediterranean.	Mediterranean.	Mediterranean, Canary Islands, coast of Norway and Ireland (coast of Chile, South America ?).

	S. multilobata Maas.‡	S. forskalii = Polycolpa forskalii Haeckel.	S. lenticula Haeckel, 1879, p. 357.
Shape and size of bell in mm.	Flat, biconvex, lenticular, 12 to 18 wide.	Flatter than a hemisphere. 20 wide, 7 high.	Lenticular, biconvex. 5 wide, 3 high.
Number of tentacles and lappets.	70. Tentacles filiform and 2 to 3 times as long as bell-diameter.	25. Tentacles 1.5 as long as bell-diameter.	16. Tentacles somewhat longer than bell-diameter.
Shape of marginal lappets.	Short and blunt.	Oval, twice as long as wide.	Nearly semicircular, one-fourth as long as lenticular center of bell.
Number of sensory-clubs upon each lappet.	1	5 to 7	3
Character of gonads.	A simple annulus in subumbrella wall of stomach.	Wide, simple annulus in ectoderm on subumbrella floor of stomach.	A wide annulus upon nearly entire subumbrella wall of stomach.
Color.	?	Gonads and tentacles light blue. Tips of tentacles darker.	?
Where found.	North of Hebrides, Scotland.	Red Sea. Tur, coast of Arabia. Indian Ocean, Pacific, and Atlantic.	Indian Ocean.

* *Ægineta paupercula* Gegenbaur, 1856, p. 263, taf. 10, fig. 10, is probably young of this medusa.

† Browne, 1903, found this Mediterranean form off coast of Norway. Probably identical with *Æquorea rhodoloma* Brandt from the coast of Chile.

‡ Distinguished by great number of lappets and tentacles.

Haeckel founded this genus in 1879, establishing it for *Solmaris godeffroyi* from Samoa, and other medusæ; but the longest-known medusa belonging to this genus is probably "*Polyxenia*" *leucostyla* of Will, 1844, from the Mediterranean.

GENERIC CHARACTERS.

Solmaridæ with a variable number of tentacles, alternating with an equal number of marginal lappets. The gonad is ring-like, *not* composed of an annular zone of saccules in the ectoderm of the subumbrella floor of the stomach. There are no peripheral stomach-pouches extending outward into the lappets, but the outer margin of the stomach is simple and circular. A marginal canal-system may or may not be present. Exumbrella sensory tracts may or may not occur above the sensory-clubs.

The outer margin of the stomach is usually simple, entire, and circular. When it displays notches or a wavy outline these appearances are not caused by intertentacular pouches in the lappets beyond the periphery of the central stomach.

The genus *Polycolpa* Haeckel, 1879, appears to be composed of immature forms with a simple, ring-like gonad around the periphery of the stomach and without peripheral stomach-pouches. These medusæ are probably the young of other forms of Solmaridæ, possibly *Solmaris*.

Haeckel records *Polycolpa zonaria*, 12 mm. wide, with 10 to 12 lappets and tentacles, 60 to 90 sensory-clubs. Genital ring narrow, with a wavy outline, slightly convex in each lappet. Color blue. Locality, Mediterranean.

Polycolpa zonorchis, 16 mm. wide, 17 lappets and tentacles, 200 to 220 sensory-clubs. Genital ring wide, swollen, developed upon the subumbrella floor of the outer two-thirds of the lower wall of the stomach. Locality, Venezuela, South America.

Polycolpa forskalii Haeckel, 1879, 1881, is evidently a *Solmaris* with a simple, ring-like gonad.

Anatomically speaking *Solmaris* may be regarded as the simplest and possibly phylogenetically the oldest of the Narcomedusæ and the others may have been derived from it.

Solmaris leucostyla Haeckel.

Polyxenia leucostyla, Will, 1844, Horæ Tergestinæ, p. 64, taf. 2, fign. 1–4, Leipzig.—Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 360.—Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 254, taf. 23, fig. 29; 1886, Embryol. Studien, an Medusen, Wien, pp. 23 (egg); 35 (segmentation); 64 (formation of entoderm), taf. 8, fign. 2–36.
Solmaris leucostylus, Haeckel, 1879, Syst. der Medusen, p. 357.

Bell flat, about 3 mm. wide, 12 to 26 slender, solid, filiform tentacles, 1.5 times as long as the bell-diameter. These tentacles project from the sides of the bell well above the lower margin.

Alternating with the tentacles are an equal number of marginal lappets each (usually) with one marginal sense-club. Thus, in specimens found by Metschnikoff, one with 18 tentacles had 17 sensory-clubs; one with 26 tentacles, 33 clubs; and one with 25 tentacles had 17 marginal sense-organs. Velum small. Stomach flat, lens-shaped, without lateral pouches. Mouth simple, closed. Gonad a wide ectodermal annulus in the subumbrella wall, around the periphery of the stomach. Tentacle-tips and sense-organs faint green, other parts colorless. Mediterranean, Messina, Villafranca, Naples, etc. It is quite common at Trieste, Adriatic, according to Graeffe, from September to January.

The early development of this medusa has been studied by Metschnikoff, 1886, and is quite different from that of *Solmaris flavescens*, with which this form has often been confounded. The egg is 0.127 to 0.147 mm. wide and is laid between 1 and 3 in the afternoon, in March and April, in the Mediterranean. Segmentation is total, but sometimes *unequal*, and then the gastrula is formed by epibole. Sometimes, however, the segmentation is total and *equal*, and then a solid morula is formed, the central cells of which become the entoderm.

It is distinguished from the common *Solmaris flavescens*, of the Mediterranean, only by its small size when mature, its large number of tentacles, and few sensory-clubs. It is possible that the two forms are mere varieties one of the other.

Solmaris flavescens.

Pachysoma flavescens, Kölliker, 1853, Zeit. für wissen. Zool., Bd. 4, p. 322.
Ægineta flavescens, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 263, taf. 10, fig. 9.
Polyxenia flavescens (*non leucostyla*), Metschnikoff, E., 1874, Zeit. für wissen. Zool., Bd. 24, p. 22, taf. 3, 4.
Solmoneta flavescens, Haeckel, 1879, Syst. der Medusen, p. 353.
(?) *Cunina discoides*, Fewkes, 1881, Bull. Museum. Comp. Zool. at Harvard College, vol. 8, p. 161, pl. 2, fig. 8; pl. 4, figs. 1, 2.
Solmoneta flavescens, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 47.
Ægineta (Solmoneta) flavescens, Maas, 1902, Sitzungsber. Gesell. für Morphol. und Physiol. München, Bd. 17, p. 14, fign. 1–18 (early development).—1908, Verhandl. deutsch. Zool. Gesellschaft, p. 124, fig. 7 (structure of the egg.)
Solmoneta flavescens, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 41.
Ægineta (Solmoneta) flavescens, Stschelkanowzeff, 1905, Nachr. Gesell. Freunde Naturw. Moskau, Bd. 110, p. 30, taf. 3, fign. 1–22; 1906, Zoolog. Centralblatt, Bd. 13, p. 678 (embryology).
Non Solmaris flavescens, Vanhöffen, 1908, Narcomedusen "*Valdivia*" Expedition, p. 58.

Flat and lens-shaped, 15 to 23 mm. in diameter. The gelatinous substance of the central disk is lenticular and quite thick, but the sides of the bell are thin, flexible, and vertical and constitute the marginal bell-lappets, or "bell-collar" of Haeckel. 12 to 17 (usually 13 to 15) long, stiff tentacles stand out at right-angles to sides of bell and are capable of but little movement; their proximal ends are inserted into the sockets in the thick gelatinous substance of the bell just above the stomach. The tentacles are about as long as the bell-diameter. Immediately beneath each tentacle and extending radially across the thin outer part of the bell between the lappets, is a thickened, solid, rib-like strand of ectoderm called the peronium. Thus in a medusa having 14 tentacles there are 14 peronia; they give support to the tentacles which arise just above them. The marginal lappets alternate with the tentacles and are therefore equal in number to the latter. There are 2 to 3 sensory-clubs (usually 2) upon each lappet. Each club contains 2 garnet-colored spherical entodermal concretions, one being large and the other small. The club itself is elongate, mounted on a slender stalk and is covered with bristles. There are no otoporpæ. The velum is large and powerful and capable of much distension and contraction. Sections cut by me and stained in Delafield's hæmatoxylin show that there are no peronial canals and no ring-canal. Stomach flat and lenticular, mouth is a simple, round opening; periphery of stomach circular. The gonad is developed in the ectoderm of the subumbrella floor of the stomach-margin. The gonads and tentacle-tips are milky to golden-greenish, the entoderm of the stomach being lighter. All other parts are perfectly transparent, excepting the concretions of the sense-clubs, which are port-wine colored.

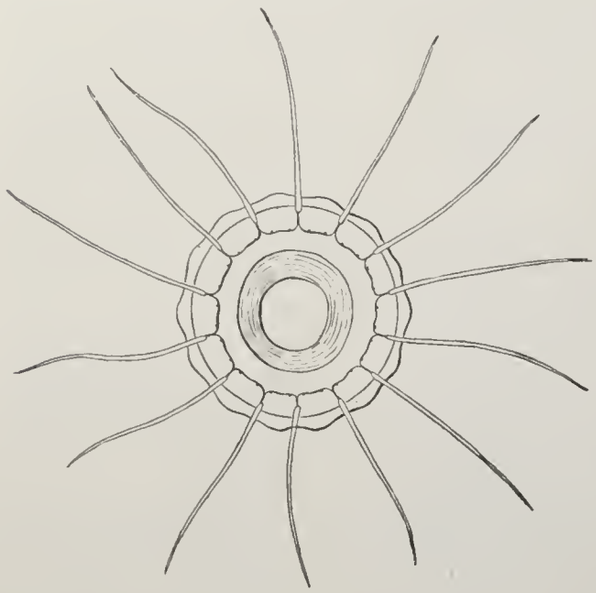


Fig. 284.—*Solmaris flavescens* (*Ægineta flavescens*), after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

This medusa is abundant in the Mediterranean, where it swims languidly near the surface.

Among 20 specimens studied from life by the author during the winter of 1907–08, at Naples, 2 had 12 tentacles, 4 had 13, 6 had 14, 4 had 15, 2 had 16, and 2 had 17 tentacles.

This form bears some resemblance to *Solmaris leucostyla*, which also occurs in the Mediterranean, but Maas, 1902, has shown that its development differs from that of *Solmaris leucostyla* as described by Metschnikoff, 1886. "*S. flavescens*" of Vanhöffen, 1908, appears to be a *Solmissus*.

According to Maas, 1902, in *S. flavescens* the egg is fertilized in the water after being dehisced from the ovary. It is opalescent, whitish, and 0.8 to 1.5 mm. in diameter. The first two cleavages are meridional and give rise to 4 equal blastomeres. The third cleavage is equatorial and may result in 4 small and 4 large blastomeres, or in 8 equal blastomeres. When the cleavage results in 4 small and 4 large blastomeres, the 4 small ones divide more rapidly than the 4 large, giving a 12-cell stage; but where the 8 blastomeres are equal they divide again at one

and the same time, giving rise to a 16-cell stage. In any event, the cells of the upper (animal) pole usually divide so as to become smaller than those of the lower. No segmentation cavity is formed; but the superficial cells divide one after another and their inner-halves migrate inward to form a loose mass of cells which gives rise to the entoderm. The planula becomes oval in outline. The gallert forms a cap-like mass of gelatinous substance between the ectoderm and entoderm at the upper end of the larva. The exumbrella entoderm cells are small

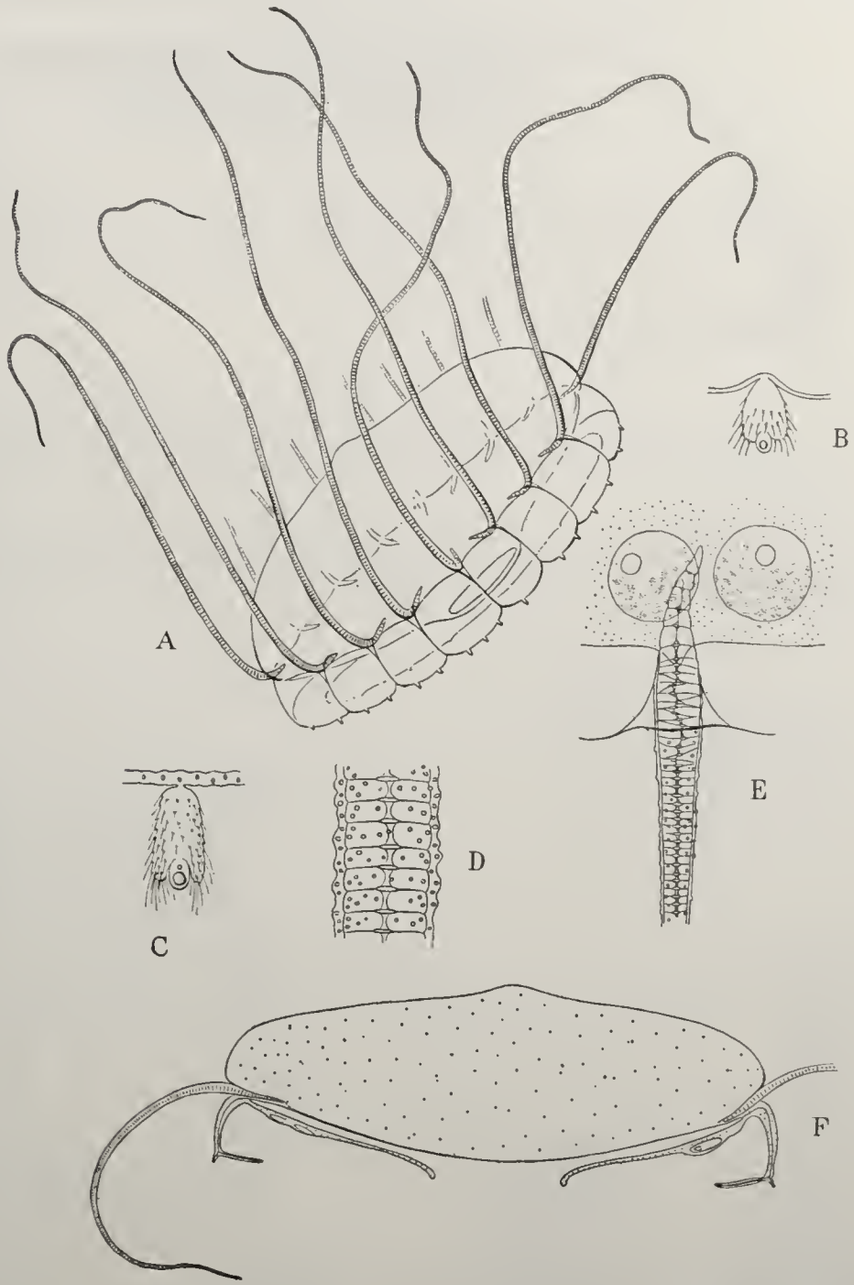


Fig. 285.—*Solmaris flavescens*, from life, by the author, at Naples Zoological Station, winter of 1907–08. *A*. Side view of mature medusa. *B*. Immature sensory-club. *C*. Fully-developed sensory-club. *D*. Tentacle. *E*. Stomach-margin showing female gonad. *F*. Diagrammatic section of medusa.

and flat while those of the subumbrella entoderm are very high and large. The tentacles grow out as wide basal bulbs from the margin and finally the bell grows out as a ring beneath and between the tentacle-bulbs. The mouth breaks through and the medusa is thus formed from the actinula.

The origination of the primitive, entoderm cells through division from the inner ends of the superficial cells of the blastula recalls the condition observed in *Liriope*.

According to Maas, if the egg be cut into two when in the 2-cell stage, each cell finally develops into a small, normal planula and medusa. If the 8-cell stage be separated into a

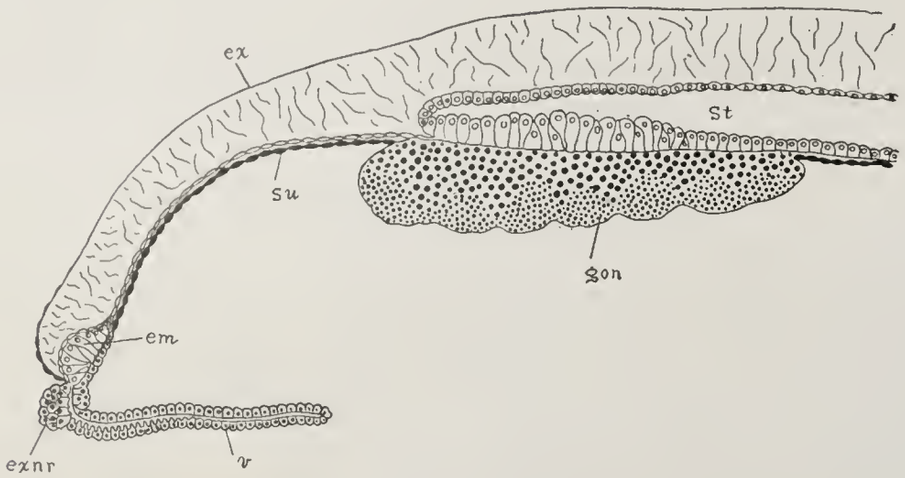
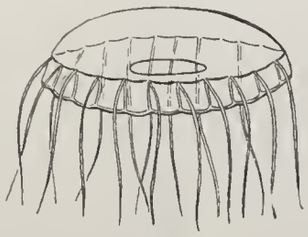


Fig. 286.—*Solmaris flavescens*. Interradial section, drawn by the author, at Naples Zoological Station. *em*, cord of entoderm at the bell-margin. *ex*, exumbrella. *exnr*, exumbrella nerve-ring. *gon*, male gonad. *st*, central stomach. *su*, subumbrella. *v*, velum. Ectodermal nuclei are shown in solid black and entodermal nuclei are represented as circles.

piece with 4 small and another with 4 large cells, the large-cell piece develops irregularly and the small cells degenerate. A meridional cut through the 8 or 12-cell stage gives a medusa with only local irregularity.



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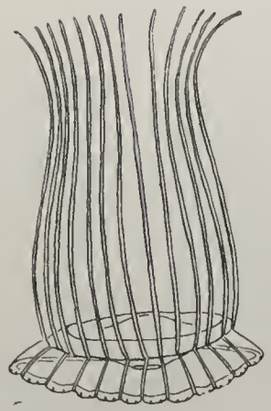

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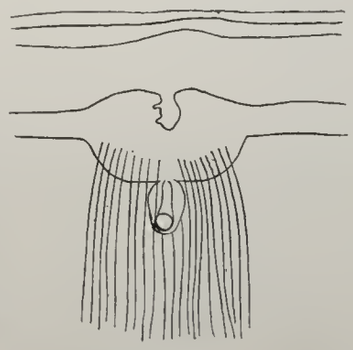

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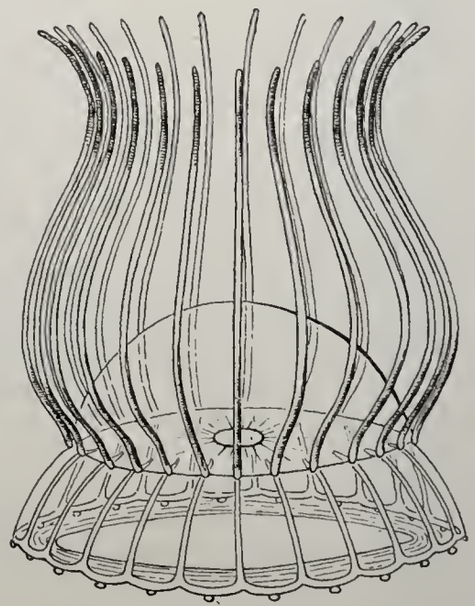

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Fig. 287.—*Solmaris solmaris* (*Ægineta solmaris*), after Gegenbaur, in Zeit. für wissen. Zool., B. 8d.
Fig. 288.—*Solmaris* (*Ægineta*) *corona*, after Keferstein and Ehlers, 1861. Entire medusa and one of its marginal sense-organs.
Fig. 289.—*Solmaris* "*coronantha*," after Haeckel, in Syst. der Medusen=*S. corona*.

Stschelkanowzeff, 1905, has made a further study of the development which would necessitate some modification of the account given by Maas. Stschelkanowzeff states that

the first two divisions are meridional and the 8-cell stage consists of 2 small cells at the animal pole, 2 large cells at the vegetative pole, and 4 cells in the equatorial zone. The morula consists of 32 cells and there is a large cell in its center which is derived from one of the large vegetative cells. This large cell gives rise to a part of the entoderm of the blastula, the remaining portion of the entoderm being derived from the superficial blastoderm as described by Maas. The genital cells originate from entodermal cells of the central blastomere, which afterward migrate into the ectoderm.

Solmaris solmaris.

Ægineta solmaris, Gegenbaur, 1856, Zeit. fur wissen. Zool., Bd. 8, p. 265, taf. 10, fign. 4, 5, fig. 10 (?).
Solmaris gegenbauri, Haeckel, 1879, Syst. der Medusen, p. 358.
Ægineta paupercula (young medusa ?), Gegenbaur, 1856, Zeit. für wissen. Zool., p. 263, taf. 10, fig. 10.

This Mediterranean species is distinguished by the large number (6 to 8) of sensory-clubs on each of its bell-lappets. In other respects it closely resembles *Solmaris flavescens*. Bell lenticular, 25 mm. wide, 12 mm. high. 18 to 20 tentacles about as long as the bell-diameter. Stomach, gonads, and tentacles milky. (See text-figure 287.)

Solmaris corona Haeckel.

Ægineta corona, Keferstein und Ehlers, 1861, Zoolog. Beitrag. aus Neapel und Messina, p. 94, taf. 14, fign. 7-9.
Solmaris corona+S. coronantha, Haeckel, 1879, Syst. der Medusen, pp. 358, 359, taf. 20, fign. 7-10.
Solmaris corona, Browne, 1903, Bergens Museums Aarbog, No. 4, p. 30.
(?) *Æquorea rhodoloma*, Brandt, 1838, Mém. Acad. St. Pétersbourg, sér. 6, tome 4, plate 2, p. 357, taf. 3, fign. 1-5.

Browne, 1903, found this medusa off the southern coasts of Ireland and Norway. It is a fairly well-known Mediterranean form.

Haeckel attempts to separate his *Solmaris "coronantha"* of the Canary Islands from *S. corona* on the ground that in *S. "coronantha"* there is but 1 sensory-club upon each lappet, whereas he states that in *S. corona* there are 2 to 3 clubs upon each lappet. Browne, 1903, finds, however, that there are usually 2 clubs, but occasionally only 1 club, on each lappet of *S. corona*, so that Haeckel's attempt to separate the species upon so slight and evidently variable character falls to the ground, and it is probable that in common with many other Narcomedusæ and Trachymedusæ this species is widely distributed over the Mediterranean and Atlantic. (See text-figures 288 and 289.)

It bears a strikingly close resemblance to Brandt's *Æquorea rhodoloma* from the Pacific coast of Chili, South America.

The bell is flat-topped with a low, conical, blunt apex. Bell 14 mm. wide, 27 to 35 tentacles, each 1.5 times as long as the bell-diameter. Usually 2 sensory-clubs on each lappet margin. The club is mounted on a large sensory cushion which bears long bristles. This medusa is distinguished from *Solmaris flavescens* by its large number of tentacles and its bristle-bearing sensory pads, the bristles in *S. flavescens* being confined to the sensory-club itself.

Solmaris forskalii.

Polycolpa forskalii, Haeckel, 1879, Syst. der Medusen, p. 328; 1881, Report Deep Sea Medusæ, *Challenger* Expedition, vol. 4, Zool., p. 31, plate 10, figs. 1-8.—Vanhöffen, 1908, Narcomedusen *Valdivia* Expedition, p. 56.

Bell flat and discoidal, 20 to 75 mm wide. A deep circumferential furrow extends around the bell, dividing the thick central part of the disk from the thin, flexible margin. This margin is divided into 24 to 30 lappets which alternate with the same number of tentacles. The tentacles project stiffly from the ring furrow and are all of equal length, being 1.5 to 2 times as long as the bell-diameter.

There are 5 to 7 sensory-clubs on the margin of each of the 25 lappets, one club being at the outer point of the lappet and the others flanking it. Each club contains 3 to 4 crystalline entodermal concretions and is mounted upon a sensory cushion which bears bristles. A short ciliated ridge of ectodermal cells extends upward over the exumbrella side of the lappet above the club. The web-like velum spans between the lappets and forms a narrow diaphragm around the edge of the bell-opening.

The flat, conical stomach is as wide as the thick central disk and the mouth is a simple, round opening at about the level of the velum. The gonad is a wide, swollen ring in the ectoderm of the subumbrella wall around the periphery of the stomach.

The gonad, tentacles, and nettle-cells along the margin of the lappets are sky-blue; the tentacle-tips being deep blue.

Found in the Red Sea, tropical Pacific, Indian, and Atlantic Oceans.

Solmaris lenticula Haeckel.

Solmaris lenticula, Haeckel, 1879, Syst. der Medusen, p. 357.

Bell biconvex, lenticular, 5 mm. wide, 3 mm. high. There are 16 tentacles somewhat longer than the bell-diameter. The marginal lappets are semicircular and not quite half as long as the diameter of the stomach. There are 3 sensory-clubs upon each lappet-margin. The gonad appears as a wide annulus upon nearly the entire subumbrella wall of the stomach. Found in the Indian Ocean. Probably only an immature form.

Solmaris multilobata Maas.

Solmaris multilobata, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 45, taf. 4, fign. 7–13.—Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 61.

Bell flat, the shape of a biconvex lens, 12 to 18 mm. wide. About 70 slender, thread-like, solid tentacles, 2 to 3 times as long as the bell-diameter. Alternating with the tentacles are an equal number of short, blunt, marginal lappets, each bearing a club-shaped sense-organ on the

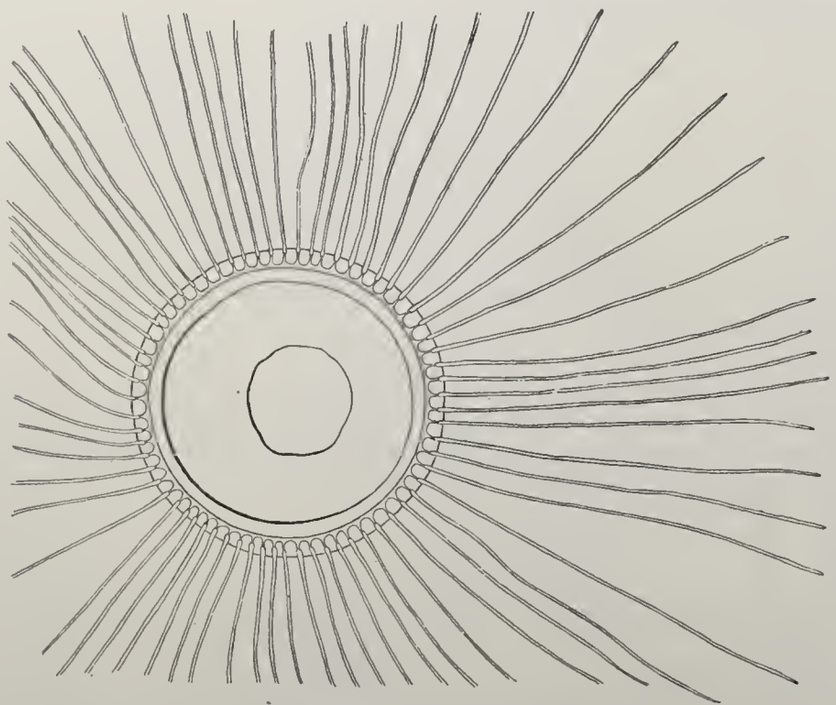


Fig. 290.—*Solmaris multilobata*, after Maas, in Ergeb. der Plankton Expedition.

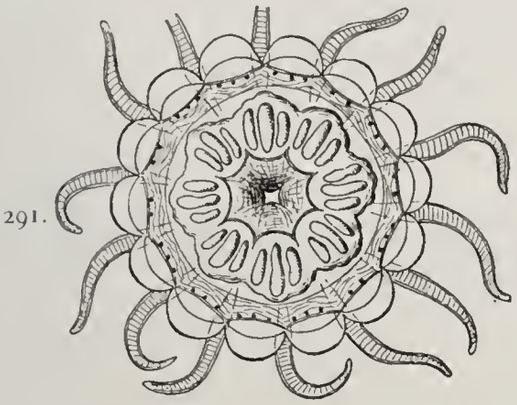
exumbrella nerve-ring. The axial cells of these clubs are entodermal and there is a single concretion in each club. The velum is not wide and spans the spaces between the lappets. The flat and lens-shaped stomach underlies the entire subumbrella surface. Mouth wide and circular. The gonad is a simple annulus in the ectodermal wall of the subumbrella. North of the Hebrides, Scotland. It is distinguished by its very numerous, thread-like tentacles. The *Valdivia* found 24 specimens of this medusa on August 8 and 9, 1898. This form may prove to be identical with *Solmaris corona*.

Genus PEGANTHA Haeckel, 1879, sens. emend.

Polyxenia + Pegasia + Pegantha + Solmoneta, Haeckel, 1879, Syst. der Medusen, pp. 332, 353.
Pegantha, Haeckel, 1881, Report *Challenger* Expedition, Zool., vol. 4, p. 36.—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 47.—Bigelow, 1904, Bull. Museum. Comp. Zool. at Harvard College, vol. 39, p. 260; 1909, Mem. *Ibid.*, p. 83.
(?) *Pegasia*, Péron et Lesueur, 1809, Annal Mus. Hist. Nat. Paris, tome 14, p. 340.
(?) *Polyxenia*, Eschscholtz, 1829, Syst. der Acal., p. 118.

GENERIC CHARACTERS.

Solmaridæ with a variable number of tentacles alternating with an equal number of marginal lappets. The gonads are found in a zone of evaginated sacs which arise from the



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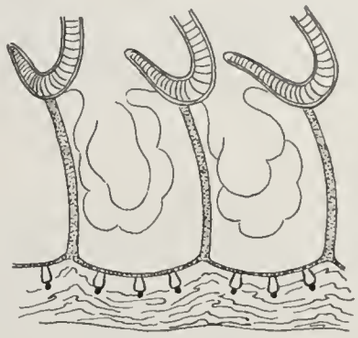

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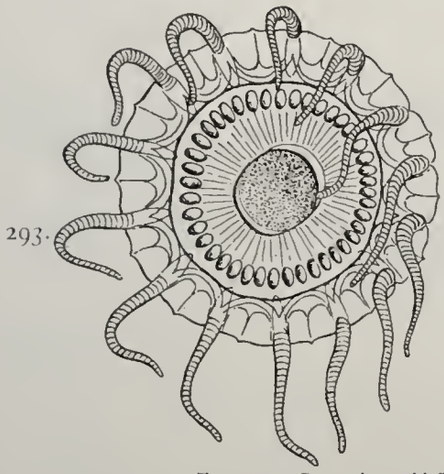

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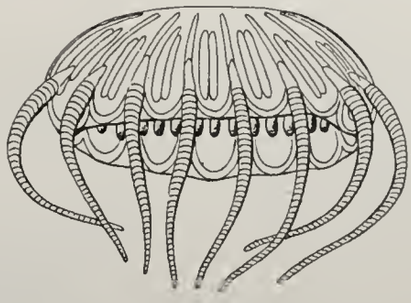

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Fig. 291.—*Pegantha goddeffroyi*, after Haeckel.
Fig. 292.—*Pegantha aureola*, after Haeckel, Syst. der Medusen, taf. 19, fig. 11.
Fig. 293.—*Pegantha triloba*, oral view, after Mayer, in Bull U. S. Bureau of Fisheries.
Fig. 294.—*Pegantha triloba*, side view, after Mayer, in Bull. U. S. Bureau of Fisheries.

subumbrella floor of the stomach, one or more in each lappet-radius. There may or may not be ectodermal, sensory tracts over the exumbrella above the marginal sense-clubs. A peripheral ring-canal system appears always to be present.

According to Haeckel, *Pegantha* is distinguished by the condition that the gonads are said to be *confined* to intertentacular outpocketings from the subumbrella floor of the stomach and are not developed upon the general subumbrella floor of the central stomach itself.

There is unfortunately, however, no sharp line of demarcation between *Pegantha*, wherein the gonads are *confined* to intertentacular saccules, and Haeckel's *Polyxenia*, wherein the gonad consists of a ring on the subumbrella floor of the stomach and also extends downward in intertentacular saccules from the floor of the stomach in the radii of the lappets.

Haeckel distinguishes *Pegantha* with ectodermal sensory tracts above the sense-clubs and *Solmoneta* without these appendages. This difference appears to me to be too slight to be of more than specific value.

Synoptic Table of Species of Pegantha.

	P. lunulata = Solmoneta lunulata Haeckel, 1879, Syst. der Medusen, p. 354.	P. aureola = Solmoneta aureola Haeckel, 1879, Syst. der Medusen, p. 354, taf. 19, fig. 11.[1]	P. pantheon Haeckel (see text).[2]	P. martagon Haeckel = P. simplex Bigelow.
Shape and size of bell in mm.	Flat, shield-shaped. 16 to 20 wide, 4 to 5 high.	Shield-shaped. 30 wide, 8 high.	"Crown-shaped." 20 wide, 10 high. Radiating ridges on exumbrella.	20 wide, 10 high. Exumbrella smooth, but with a median ridge and a ridge above otoporpæ of each lappet.
Number of tentacles and lappets.	24. Tentacles not quite as long as bell-diameter.	32. Tentacles twice as long as bell-diameter.	18. Tentacles as long as bell-diameter.	9 to 13. Tentacles as long as bell-diameter.
Shape of marginal lappets.	Quadratic, somewhat longer than wide.	Rectangular, 1.5 times as long as wide.	Oval, 1.5 times as long as wide.	Bluntly oval.
Number of sense-clubs upon each lappet.	5 to 6	3	23 to 25	6 to 9
Character of gonads.	A half-moon-shaped genital sac in each lappet-radius.	In radius of each lappet an oval genital sac with swollen wart-like outpocketings over surface.	In each lappet-radius a simple gonad in form of round, wide, finely-folded leaf.	A simple, irregularly lobed sac in radius of each lappet.
Color.	Stomach and male gonads bright-yellow. Tentacle tips, golden-yellow. Concretions orange.	Stomach light-yellow. Gonads and tentacles golden-yellow. Tentacles tipped with "aurora" color and red.	?	Colorless.
Where found.	Canary Islands, Atlantic.	Red Sea, coast of Arabia.	Philippine Islands.	Tropical Pacific, and Indian Ocean.

	P. triloba Haeckel.	P. magnifica Haeckel, 1879, p. 333.[3]	P. dactyletra Maas (see text).	P. punctata = Solmaris punctatus Haeckel = Æquorea punctata Quoy and Gaimard.[4]
Shape and size of bell in mm.	Flatter than a hemisphere, about 25 wide.	Flat, shield-shaped. 50 wide, 12 high. Exumbrella besprinkled with conical nettling warts.	Thick, doubly convex. 20 to 30 wide. 32 radial and interradial ridges on exumbrella.	Shield-shaped. 90 wide, 25 high.
Number of tentacles and lappets.	11 to 16	30	16	24. Tentacles short and thick, hardly 0.5 as long as bell-radius.
Shape of marginal lappets.	Oval.	Tongue-shaped, or horseshoe-shaped. Half as long as bell-radius, with 3 radiating ridges on each.	Lappets with 5 angles.	Semicircular.
Number of sense-clubs upon each lappet.	18 to 20	30 to 35	5 to 7	6 to 9
Character of gonads.	A 3-lobed sac in each lappet-radius.	In each lappet-radius there is a cluster of 5 to 8 egg-shaped sacs of various sizes.	Each gonad is a sac-like body, which in turn gives rise to 5 finger-shaped processes.	A wide annulus, occupying nearly entire width of subumbrella surface of stomach and extending downward in 24 intertentacular subumbrella saccules in radii of marginal lappets.
Color.	Violet-pink.	?	?	Colorless.
Where found.	Tropical Atlantic, Pacific, Indian Oceans.	Tropical Pacific.	In middle of Atlantic in N. lat. 28°.	Hawaiian Islands, Pacific.

[1] *Polyxenia flavibrachia* Brandt, 1838, from tropical Pacific, is probably identical with this species.
[2] Is this identical with *P. quadriloba*?
[3] A preserved specimen was studied by Haeckel.
[4] *Solmaris astrozona* Haeckel is probably identical with this species; but Haeckel's specimen had only 16 lappet-pouches. It is from the China Sea.

*Synoptic Table of Species of Pegantha.**—Continued.

	Pegantha godeffroyi=Solmaris godeffroyi Haeckel, 1879, p. 355, taf. 19, fig. 12.	Pegantha smaragdina Bigelow.	Pegantha? weberi. S. weberi Haeckel, 1879, Syst. der Medusen, p. 638.	Pegantha? P. cyanostyla Eschscholtz.
Shape and size of bell in mm.	Hemispherical. Exumbrella smooth, 6 wide, 3 high.	Lenticular. Exumbrella smooth, 73 wide.	Shield-shaped, 50 wide, 16 high.	75 wide, 20 high.
Number of tentacles and lappets.	14. Tentacles short and thick. Shorter than bell-radius.	28 to 34. Nearly as long as bell-diameter.	27. Tentacles thin, not quite as long as bell-diameter.	16 to 18. Tentacles half as long as bell-radius.
Shape of marginal lappets.	Semicircular, not quite half as long as the lenticular center of bell.	Quadrate, about as long as wide.	Rectangular, about one-third as long as radius of central lenticular part of bell.	Rounded, semicircular.
Number of sense-clubs upon each lappet.	2 to 3	6 to 8	1	25 to 30
Character of gonads.	A wide annulus, with star-like, octagonal outline. 24 coffee-bean-shaped saccules in subumbrella floor of stomach, 3 in each octant.	A smooth simple pouch in each lappet radius.	Gonad developed upon nearly entire subumbrella wall of stomach, and divided into 8 wedge-shaped marginal lappets by 8 radial furrows.	Narrow ring in subumbrella near margin of stomach and extending downward in crescentic, blind sacs in radii of lappets, each blind sac giving rise to about 8 radiating, ridge-like saccules. It is impossible to determine exact nature of blind sacs. Are they subumbrella saccules?
Color.	?	Opaque lemon-yellow.	?	Gonads light-blue. Tentacles sky-blue.
Where found.	Samoa, Pacific Ocean.	Coast of Peru.	Tropical zone of the Pacific Ocean.	Atlantic Ocean, Azores, Canary Islands, Indian Ocean, Mediterranean, tropical Pacific.
Remarks.	Mouth said to have 4 lips instead of being round opening as in all other species.	Closely allied to *P. clara*, (see text).		This form appears to be identical with P. cyanolina Haeckel, from the Indian Ocean. It is probably of world-wide distribution throughout warm and tropical seas.

*For *Pegantha clara* and *P. laevis* see text.

As Maas has shown, the peripheral ring-canal system in Narcomedusæ is largely degenerate and is subject to such variability as to be worthless as a basis of distinction of more than specific significance. He sectioned *Pegantha dactyletra* and showed that this medusa has a marginal ring-canal system which indeed is present in all known forms of *Pegantha*.

Bigelow, 1909, discovered a form of development of parasitic larvæ from the egg in *Pegantha* closely resembling that seen in *Cunina proboscidea*. He also found an internal budding of stolons in another species, *Pegantha laevis*.

I think that Haeckel's "*Pegasia*," "*Polyxenia*," and "*Pegantha*" should be united into a single genus and that this should be called *Pegantha*. There would then be but two genera of the Solmaridæ: *Solmaris without* saccules upon the subumbrella floor of the stomach and *Pegantha with* such diverticula.

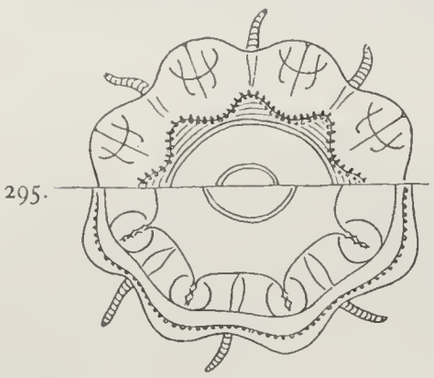
The names *Pegasia* and *Polyxenia* are older than *Pegantha*, but they are so hopelessly confused through vague and inaccurate description that I believe it will be necessary to allow them to lapse into oblivion.

The subumbrella saccules serve the purpose of increasing the area over which the gonads are developed. These saccules are prevented from collapsing by papilla-like, gelatinous cores which project downward from the exumbrella floor of the stomach into the central cavity of the saccule.

Pegantha pantheon Haeckel.

Pegantha pantheon, HAECKEL, 1879, Syst. der Medusen, p. 332; 1881, Report Deep Sea Medusæ *Challenger* Expedition, Zool., vol. 4, p. 37, plates 11, 12, figs. 1 to 12.

Bell about 20 mm. wide and 10 mm. high. A deep coronal furrow separates the central apical disk from the marginal zone of gelatinous lappets. Gelatinous substance of central disk thick and about one-half to two-thirds as wide as entire medusa. The exumbrella exhibits numerous branched, strongly projecting ribs, between which there are deep radial furrows. 18 of these ribs are more prominent than the others and extend outward over the middle of each of the 18 lappets. These main ribs increase in thickness from the center outward and give rise to side branches; thus a main central rib flanked on either side by several less prominent ribs extends outward over each of the lappets.



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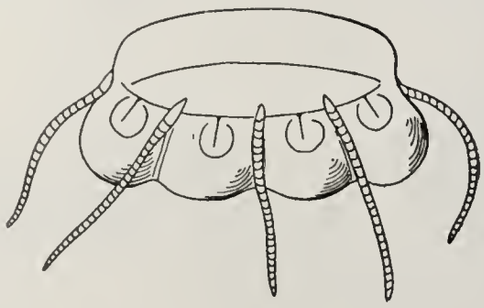

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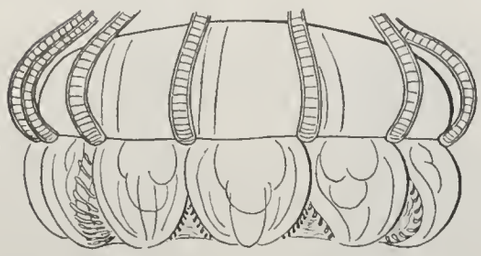

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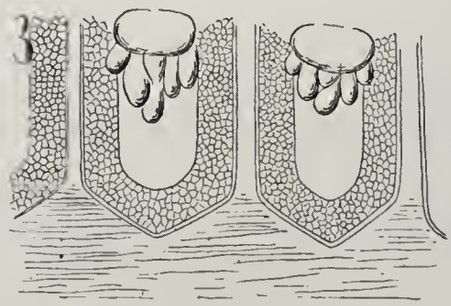


298.

FIG. 295.—*Pegantha martagon* (young medusa), after Bigelow, in Bull. Mus. Comp. Zool. at Harvard College. Upper half gives appearance of contracted bell, while lower half shows expansion.
FIG. 296.—*Pegantha martagon* (young medusa), after Bigelow, in Bull. Mus. Comp. Zool. at Harvard College.
FIG. 297.—*Pegantha triloba*, after Haeckel.
FIG. 298.—*Pegantha dactyletra*, after Maas, in Ergeb. Plankton Expedition.

The 18 oval lappets are about half as broad as long and alternate in position with 18 tentacles which project stiffly from the sides of the bell, their roots being inserted in the zone of the deep ring-furrow which separates the central, apical, disk-like part of the bell from the more marginal zone of the 18 lappets. These tentacles are of uniform length and taper gradually from base to tip. They are about as long as the bell-diameter; their entoderm consists of a single row of chordate cells, placed coin-like one after another in an axial row. The roots of the tentacles taper inward to the floor of the stomach with which their entoderm is continuous. A broken ring of nematocysts partially embraces each tentacle at its base, leaving its upper side free. 23 to 25 marginal sense-clubs arise from the aboral side of each of the 18 lappets. Thus there are 400 to 450 of these clubs. Each club is elongate, narrow at its base but widest at its free end, and contains an axial row of 3 to 5 crystals inclosed in large entodermal cells. The club arises from a sensory cushion provided with long bristles, and above this cushion there is a well-defined, swollen tract of cells over the exumbrella side of the lappet. These tracts are oval in outline and about as long as the clubs themselves and they converge slightly toward the axial line of the lappet. There is a thick nerve and nematocyst-ring around the exumbrella margin of the lappets above the velum. The velum is well developed and spans the spaces between the edges of adjacent lappets, partially closing the bell-opening in the manner of a diaphragm. Its circular muscles are well developed.

The central stomach is a lenticular pouch as wide as the central disk of the medusa. Peripherally it gives rise to 18 loop-canals which extend outward on both sides of the tentacles around the margin of each lappet. These 18 "loop-canals" are flat, ribbon-like, and about one-eighth as wide as the lappets themselves, and their entoderm is ciliated. The mouth is a simple, round opening with thick swollen lips. The gonads are developed in the subumbrella ectoderm over 18 folded, sac-shaped, peripheral outpocketings of the rim of the stomach, there being one of these pouches on the subumbrella side of each of the 18 lappets.

Found at a depth of 82 fathoms on October 26, 1874, near Mindanao, Philippine Islands.

Beautifully figured and described in detail by Haeckel, 1881.

Pegantha martagon Haeckel.

Pegantha martagon, Haeckel, 1879, Syst. der Medusen, p. 332.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 83, plate 18, figs. 1–8.
Pegantha simplex (young medusa), Bigelow, H. B., 1904, Bull. Museum Comp. Zool. at Harvard College, vol. 39, p. 260, plate 5, figs. 19, 20.

Bigelow gives the best description of this medusa. Bell 20 mm. wide, hemispherical or higher, with thick gelatinous substance. Exumbrella centripetal to tentacle insertions smooth. Each lappet sculptured by a median ridge and a less prominent ridge in the line of each otoporpa. 9 to 13 lappets and tentacles. Lappet-margins evenly rounded. 6 to 9 sensory-clubs and otoporpæ on each lappet-margin. Each club contains 2 to 3 concretions. Stomach lenticular, without marginal pockets. Peronial and ring-canals well developed. Mouth a round opening. An irregularly lobed genital sac in each lappet radius. Cavity of each genital sac occupied by a plug of gelatinous substance. Colorless. Tropical Pacific and Indian Oceans. (See text-fig. 295 and 296.)

Pegantha triloba Haeckel.

Pegantha triloba, Haeckel, 1879, Syst. der Medusen, p. 333, taf. 19, fign. 4–7.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 87, plates 14, 16, 20, and 45.
Solmaris insculpta, Mayer, 1906, Bull. U. S. Bureau of Fisheries, vol. 23, p. 1140, plate 3, figs. 8, 9.
(?)*Pegantha quadriloba*, Haeckel, 1879, Syst. der Medusen, p. 333.
Pegantha, sp., Fewkes, 1889, Report U. S. Commission Fish and Fisheries for 1886, p. 527, plate 1, figs. 1, 2.
(?)*Polyxenia cyanogramma*, Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 56, taf. 2, fig. 8.

The best description of this medusa is given by Dr. H. B. Bigelow, 1909; my own account in 1906, containing several serious errors, is untrustworthy.

According to Bigelow, who studied both living and preserved specimens, the bell is 22 mm. wide and 12 high, with extremely rigid, gelatinous substance.

From the insertion of each tentacle a deep furrow runs inward nearly to the apex of the bell; on either side of these furrows there are ridges which extend down to the margin of the lappets; in the middle lines of the lappets and also extending to the bell apex are a second series of ridges, and finally there are less prominent ridges confined to the lappets along the lines of the otoporpæ. There are 12 to 16 ovate, pointed lappets alternating with an equal number of stiff tentacles which curve inward into the bell-cavity and are about as long as the bell-diameter. 18 to 20 sensory-clubs per lappet. Each club with 2 to 3 concretions and situated upon a sensory pad. Long tapering otoporpæ extend upward from the sensory pads to the level of the bases of the tentacles. These otoporpæ anastomose to some extent over the exumbrella, and they gradually grow narrower and narrower above the bell-margin until they disappear. Stomach lenticular, mouth a round opening, peripheral and peronial canals well developed. A zone of gonads in the ectoderm of the margin of the stomach projecting into the lappet cavities. Each gonad 3-lobed. The central lobe of each gonad is supported by a plug of gelatinous substance, while the lateral lobes are flat, leaf-like, and variously subdivided.

The entire medusa is of a delicate violet-pink, the entoderm being of deeper hue. The distal parts of the exumbral ridges and the otoporpæ are deep purple. (See fig. 297.)

Widely distributed over the tropical Pacific, Atlantic, and Indian Oceans. Haeckel's *P. quadriloba* is probably the same medusa, for some of the gonads of *P. triloba* occasionally display 4 lobes.

Polyxenia cyanogramma of Vanhöffen is very briefly described, but is probably *P. triloba*. It is 17 mm. wide, has 15 tentacles; gonads 3-lobed. There are 48 radiating ridges over the

lappets and these anastomose so that there are only 13 near the center of the exumbrella. These ridges are pigmented with brownish-purple. The bell and tentacles are bluish-violet. Indian Ocean, east of Zanzibar.

Pegantha dactyletra Maas.

Pegantha dactyletra, Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 47, taf. 5, fign. 1–8.

Bell thick, doubly convex, 25 to 30 mm. wide. The exumbrella displays 32 ridges which radiate outward in the radii of tentacles and lappets. 16 solid tentacles alternating with 16 five-angled marginal lappets. 5 to 7 sensory-clubs on outer margin of each lappet. Stomach wide and lenticular, the mouth a wide, round opening with thick margin. These occupy the middle of the subumbrella side of each lappet. Each gonad is a large sac-like body, which in turn gives rise to about 5 somewhat irregular finger-shaped diverticula. The 16 wide, marginal loop-canals extend outward from the central stomach and loop around the margin of each of the 16 lappets. These insertions of the tentacles lie between the places of origin of each adjacent pair of loop-canals.

A single specimen was found by the Plankton expedition on the surface on August 22, 1889, in the middle of the Atlantic in about N. lat. 28°. Maas sectioned the medusa, thus demonstrating the presence of a marginal canal system. (See text-fig. 298.)

Pegantha laevis H. B. Bigelow.

Pegantha laevis, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 97, plates 16, 20, and 27.

This form resembles *P. dactyletra* Maas in its gonads, sensory-clubs, and form of lappets but its exumbrella is plain and without the sculpturing seen in *P. dactyletra*. Bigelow's specimens of *P. laevis* were 28 to 41 mm. in diameter and had 16 to 22 tentacles.

Bigelow found that solid, ciliated, stolon-like larvæ, or buds, are budded off from the entoderm of the ring-canal, the ectoderm apparently taking no part in their formation. Tropical Pacific, Hawaiian Islands to the coast of Peru.

Pegantha sieboldii.

Pegasia sieboldii, Haeckel, 1879, Syst. der Medusen, p. 331.

Bell crown-shaped, 20 mm. wide, 10 mm. high. 12 tentacles, each twice as long as bell-diameter. 12 oval lappets alternate with the 12 tentacles. 16 to 18 sensory-clubs upon each lappet, 200 to 220 in all. The inner ring of gonads is small and simple, bending convexly outward between tentacles. The outer gonad consists of 12 half-moon-shaped pouches in the upper third of each subumbrella lappet saccule; each of these half-moon-shaped gonads is divided by three radiating furrows into four minor lappets, the two median of which are twice as large as the two outermost. 12 deep, radiating furrows arranged in pairs on the exumbrella. The description is based upon a single specimen studied by Haeckel and found in the tropical Atlantic. It is probably identical with *Pegantha dodecagona* Péron and Lesueur.

Pegantha dodecagona Péron et Lesueur.

Pegasia dodecagona, Péron et Lesueur, 1809, Ann. Mus. Hist. Nat. Paris, tome 14, p. 341.—Blainville, 1834, Manuel d'Actinologie, p. 281, plate 33, fig. 2.—Haeckel, 1879, Syst. der Medusen, p. 331.

Bell 40 mm. wide, 12 mm. high, cap-shaped, with smooth exumbrella surface. 12 tentacles, each as long as bell-radius. 12 semicircular lappets alternating with the 12 tentacles. 10 to 12 sense-clubs on each lappet, 120 to 140 in all. The inner gonad is a small, simple ring, while the outer one consists of 12 simple, large, egg-shaped sacs, each one of which arises from the subumbrella floor of the stomach in the radius of a lappet. This species is found in the south Atlantic. The best description is that of Haeckel who studied an original specimen in Péron's collection. Are these two systems of gonads so sharply separated as one would be led to suppose from Haeckel's description?

Pegantha punctata.

Æquorea punctata, Quoy et Gaimard, 1824, Voyage de l'*Uranie*, Zool., p. 564, plate 85, fig. 4.
Solmaris punctatus, Haeckel, 1879, Syst. der Medusen, p. 356.
(?) *Solmaris astrozona*, Haeckel, *Ibid.*, p. 357 (China Sea).

This medusa appears to belong in the genus *Pegantha* rather than in *Solmaris*, for its gonad extends outward in saccules from the subumbrella floor of the stomach. The typical specimens are from the Hawaiian Islands and Pacific Ocean, but a closely allied, if not identical, medusa is described by Haeckel from the China Sea under the name *Solmaris astrozona*. Haeckel had only one (half-grown ?) specimen and this had only half as many genital pouches, but the same number of tentacles and lappets as in *P. punctata*.

Bell shield-shaped, 90 mm. wide, 25 mm. thick. 24 short, thick tentacles hardly half as long as bell-radius. 24 marginal lappets, semicircular, 6 to 9 sense-clubs on each lappet. The gonad consists in a ring of subumbrella saccules upon the subumbrella floor of the stomach, there being a single saccule in each lappet radius, alternating thus with the radii of the tentacles. The gonad is also diffusely developed over the ectodermal floor of the subumbrella under the stomach. The medusa is colorless. Hawaiian Islands, tropical Pacific.

Pegantha cyanostylis.

Polyxenia cyanostylis, Eschscholtz, 1829, Syst. der Acalephen, p. 119, taf. 10, fign. 1*a*–1*c*.—Haeckel, 1879, Syst. der Medusen, p. 330.
Polyxenia cyanolina, Haeckel, *Ibid.*, p. 330.
(?) *Mollicina, medusa*, Forskål, 1775, Descript. animal. itin. orient., p. 109; Icon., tab. 33, fig. c.
(?) *Foveolia mollicina*, de Blainville, 1834, Man. d'Actinologie, p. 280, plate 33, fig. 1.
(?) *Foveolia diadema*, Péron et Lesueur, 1809, Annal. Mus. Hist. Nat., tome 14, p. 340.
(?) *Æquorea cyanogramma*, Quoy et Gaimard, 1824, Voyage de l'*Uranie*, etc., p. 563, plate 84, figs. 7, 8.

The typical specimens are described by Eschscholtz and Haeckel from the north of the Azores and from the Canary Islands, but *P. cyanolina* Haeckel, from the Indian Ocean, appears to be the same medusa in a young stage wherein there are but 13 to 15 sense-clubs on each lappet margin instead of 25 to 30, and 4 instead of 8 folds in each genital sac in each lappet radius as in *P. cyanostylis*. Haeckel's *P. cyanolina* is only 20 mm. wide, whereas the Atlantic medusa is about 60 to 80 mm. wide.

Foveolia mollicina and *F. diadema* Péron and Lesueur and *Æquorea cyanogramma* Quoy and Gaimard are so vaguely described that their identity must remain in doubt, but they are closely related to, if not identical with, *P. cyanostylis*. If they be identical with *P. cyanostylis*, this medusa is of world-wide distribution throughout warm and tropical seas, a condition commonly observed among species of Trachymedusæ and Narcomedusæ, which, being independent of the conditions afforded by a shore for their development, range widely over the open ocean. This subject is ably discussed by Maas, 1893, Natural Science, London, vol. 2, pp. 92–99.

P. cyanostylis may be described from the accounts of older authors as follows: Flat and bell-shaped, about 40 to 50 mm. wide and 20 to 30 mm. high. There are 16 to 18 tentacles, each about as long as the bell-diameter. 16 to 18 marginal lappets, each twice as long as wide and somewhat rectangular in shape. 13 to 30 marginal sense-clubs upon each lappet-margin. The gonads are found in a peripheral zone of small sickle-shaped, or half-moon-like, folded sacs, one of which is found in each lappet-cavity. The medusa is colorless or light bluish. It is found in the tropical Atlantic. It may be identical with *P. triloba*.

Pegantha clara R. P. Bigelow.

Pegantha clara, Bigelow, R. P., 1909, Biological Bulletin, vol. 16, p. 80, 2 figs.

Bell lenticular, doubly convex, 53 mm. wide, 20 mm. thick, exumbrella smooth. 28 bell-lappets, all similar each to each, alternating with 28 tentacles spaced at equal distances apart. 14 of these tentacles are long and range between 33 to 56 mm. in length; and they alternate with 14 smaller tentacles ranging in length from 11 to 35 mm. The insertions of the long set of tentacles are farther upward (above the margin) and inward (toward the center) than are the insertions of the short tentacles. The tentacles taper gradually to their pointed tips and their entodermal cores are composed of a row of chordate cells. The sensory-clubs appear to have been destroyed by the formalin in which the medusa is preserved; but there are 2 to 5, usually 3, long, slender, linear, somewhat tortuous, sensory tracts (otoporpæ) which extend from the bell-margin about half the distance up the exumbrella side of each lappet.

The velum is simple, annular, and provided with powerful circular muscles. The mouth is a simple annular opening at the thick lenticular center of the subumbrella.

28 simple, unilobular saccules project downward into the bell-cavity at the stomach-margin, one in each antimere. These bag-like protrusions thus alternate with the radii of the tentacles and contain the genital organs, the specimen being a male. The marginal ring-canal, or "festoon-canal," is very wide. It extends down the sides of the peronial strand on either side of the insertion of each tentacle and along the margin of each lappet. It is thus broken up into 28 loops, one in each antimere.

The gelatinous substance of the bell is hyaline. The tentacles, gonads, stomach, and festoon-canal are milky—slightly brown in formalin.

The medusa is probably immature, for half of its tentacles are of small size and belong apparently to a set which is in process of development. The specimen is perfect and is well preserved in formalin.

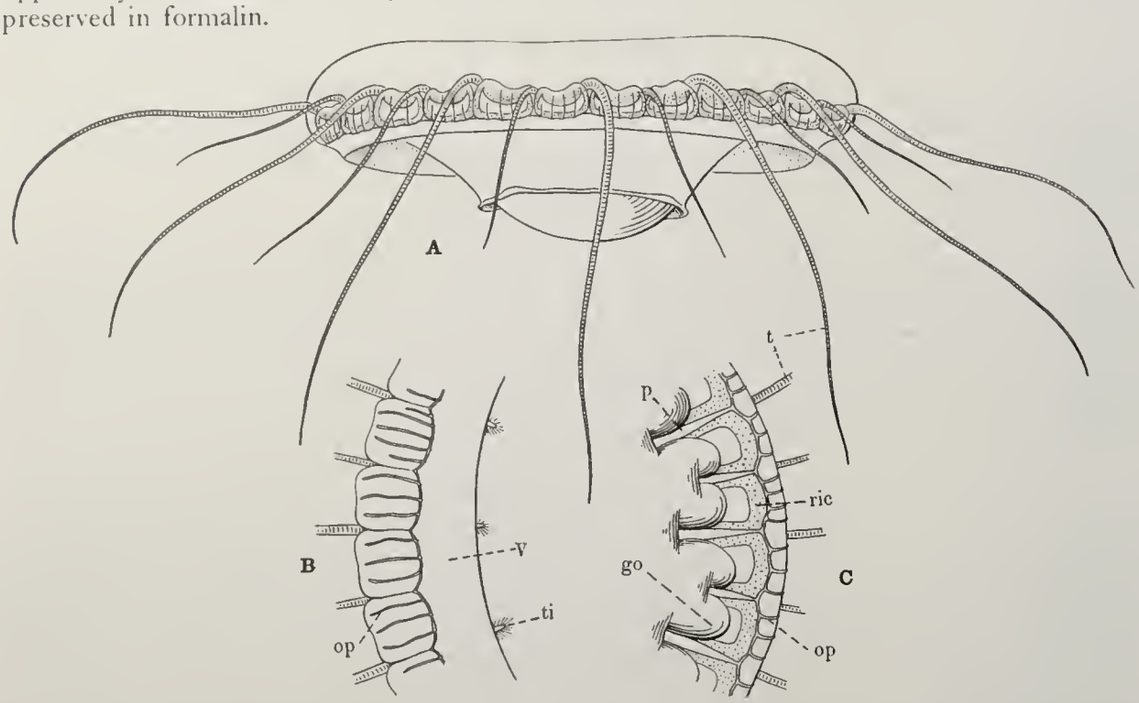


Fig. 298A.—*Pegantha clara*. *A*, side view. *B*, oral view of part of bell-margin showing velum (V), otoporpæ (op), and insertions of long set of tentacles (ti). *C*, oral view of part of bell-margin, showing genital saccules of subumbrella (go), otoporpæ (op), peronial strands. (p), marginal festoon-canal (ric), and tentacles (t).

It is distinguished from *P. cyanostylis* by having only 2 to 5 sense-clubs upon each lappet, whereas in *P. cyanostylis* there are 25 or 30. It is distinguished from *P. punctata* by its long, slender tentacles.

It is due to the generous permission of Prof. Robert P. Bigelow that I am permitted not only to study the single specimen of this rare medusa, but also to copy the excellent figures which he made of it soon after its capture by the U. S. Fish Commission steamer *Fish Hawk* on the surface, near the borders of the Gulf Stream, off Woods Hole, Massachusetts, in September, 1899, Station No. 7068.

Pegantha smaragdina H. B. Bigelow.

Pegantha smaragdina, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. Harvard College, vol. 37, p. 90, plates 14, 19, 22–26.

The resemblances between this medusa and R. P. Bigelow's *P. clara* are so close that the two may prove to be identical; in which case the form should be called *P. clara*, this name having a publication precedence of a few weeks over *P. smaragdina*. *P. smaragdina* appears to be distinguished from *P. clara*, however, by its flatter, less doubly convex bell and by its decided lemon-yellow color.

The bell in *P. smaragdina* is 73 mm. wide, 15 mm. high, being low, flat, and without sculpturing. 28 to 34 tentacles and lappets. Lappets quadrate about as long as broad, as in *P. clara*. Tentacles stiff, tapering, nearly as long as bell-diameter, as in *P. clara*. Usually

6, occasionally 7 to 8 sensory-clubs per lappet, each containing 3 to 5 concretions. These sensory-clubs are placed upon bristle-bearing sensory-pads and linear otoporpæ extend upward over the exumbrella above each club about half the length of the lappet as in *P. clara*. Gonads and gastrovascular system as in *P. clara*.

Stomach, gonads, and canals deep opaque lemon-yellow, this color being due to minute, highly refractive orange or yellow pigment granules confined to the ectoderm. Found on the surface in the Humboldt current off Peru, South America.

Bigelow discovered a development of larvæ in this species which is analogous to the process seen in *Cunina proboscidea*. This development of larvæ in *P. smaragdina* begins in the gelatinous substance of the exumbrella near the margin of the gastric cavity. The ovum is probably fertilized as was observed by Stshelkanowzeff in *C. proboscidea*, but Bigelow did not observe the process of fertilization. In the earliest stage recognized by Bigelow there is a spherical cell which is destined to become the larva and which is inclosed by a vacuolated cell destined to be the "nurse cell." The inclosed cell divides completely by mitosis and a solid morula is formed, which remains inclosed by the nurse cell. This nurse cell may remain undivided, but occasionally it divides once or twice and one or more of the resulting nuclei may degenerate.

The larva then penetrates through the entodermal wall of the stomach and enters the gastric cavity, and during this process the nurse-cell disappears. The entoderm is formed by secondary delamination as described by Metschnikoff in *C. proboscidea*. After entering the gastric cavity the larva elongates and resembles a small, detached tentacle with chordate entoderm incased in a layer of ectoderm. A cavity appears in the entoderm near one end of the larva and the ectoderm becomes thin at one side near this end of the larva and the mouth breaks through. The main part of the larva goes to form the first tentacle. A second tentacle then develops 180° apart from the first, and then other tentacles develop irregularly. Larvæ with 4 or more tentacles often produce medusa buds at their aboral pole as is seen in *Cunina proboscidea* and *C. prolifera* (see text-fig. 320*b*). The bud may remain attached until it develops tentacles and a mouth at the pole opposite to that of attachment, or it may be set free as a mere sac. Two buds may be developing at one and the same time. The bud-larvæ after being set free are similar in all respects to those developed directly from the egg. The developing medusæ flatten out, become about 3 mm. wide with thin, gelatinous substance, 10 to 12 tentacles, and 2 to 3 sensory-clubs per marginal lappet. No otoporpæ. The lappets are short and broad with indistinct incisions between them. The stomach is a simple sac with a circular entire margin, no marginal canals, and a round mouth-opening. The gonads appear to develop diffusely in the ectoderm over the subumbrella wall of the stomach. The medusæ swim actively within the stomach of their parent, through whose mouth they escape to lead an independent existence. In their characters they resemble the genus *Solmaris*.

Family ÆGINIDÆ sens. ampl.

Cunanthidæ+Æginidæ, Haeckel, 1879, Syst. der Medusen, pp. 310, 334.

Narcomedusæ in which the stomach-margin is not plain and circular, but gives rise to outwardly projecting, marginal pouches.

REMARKS ON THE GENERA OF THE ÆGINIDÆ.

Cunantha: "*Cunantha*" *primigenia* and *C. petasoides* Haeckel, 1879, pp. 314, 315, are apparently larval stages of *Ægina*. *Cunantha striata* Haeckel may possibly become mature in condition postulated for *Cunantha?*

Ægina: These medusæ develop through a "*Cunantha*" stage and generally become mature in *Ægina* stage, *sens. strict.*, with 8 adradial stomach-pouches; but a few acquire 16 peripheral stomach lobes before attaining maturity.

Solmundella: This genus is derived from *Ægina* by disappearance of half of its tentacles, reducing them from 4 to 2.

Hydroctena: Distinguished by its well-developed apical sense-organ and gelatinous axial cores of tentacles. No peronial strands, although basal sheaths of tentacles may be remnants of peronial furrows. This form may be derived from *Solmundella*. The larval *Solmundella* has a simple, ciliated, apical plate.

Cunoctantha: Closely related to *Cunina*, but is 8-rayed.

Cunoctona: "*Cunoctona*" of Haeckel is only a stage in ontogeny of *Æginura*.

Æginopsis: Derived from *Æginura* by disappearance of 4 interradial tentacles. *Æginopsis* bears same relation to *Æginura* as *Solmundella* does to *Ægina*.

Cunina: Closely related to *Cunoctantha* but has more than 8 rays.

Solmissus: Closely related to *Cunina* but it is without otoporpæ or marginal loop-canals. Otoporpæ are always present and loop-canals may be present in *Cunina*.

Cunissa: "*Æginodorus*" Haeckel is only a special case of *Cunissa* in which there are 16 tenacles.

Æginodiscus: This is apparently derived from an Æginodorus-like medusa by disappearance of every alternate tentacle.

A synopsis of the genera arranged to indicate their probable phylogenetic affinities is as follows:

Synopsis of the Genera of the Æginidæ.

	Cunantha Haeckel, 1879. (This is probably only a transient developmental stage of Ægina.)	Ægina Eschscholtz, 1829, sens. emend.	Solmundella Haeckel, 1879, sens. emend.	Hydroctena, Dawydoff, 1903.	Cunoctantha, Haeckel, 1879.
Equivalent in Haeckel's System der Medusen, 1879, and page-reference to description in his system.	Cunantha, p. 314.	Cunarcba + Ægina + Solmundus, pp. 315, 337, 351.	Æginella + Solmundella, pp. 340, 352.	Not recorded.	Cunoctantha, p. 316.
Number of tentacles.	4	4 to 6	2	2	8
Number of peronial strands.	4	4 to 6	4	None. Disappeared ?	8
Number and character of primary stomach-pouches in radii of peronial strands.	4 simple, not cleft.	4 to 6 cleft so as to form 8 to 12 adradial pouches.	4 cleft, so as to form 8 adradial pouches.	2 simple, uncleft, in tentacular radii.	8 simple, not cleft.
Number and character of peripheral lobes of the stomach-pouches.	4 canal-like. Distal ends simple, entire, not cleft.	8 to 12 lobes in adradii. These may in turn be divided by median clefts, thus giving 16 to 24 shallow, peripheral lobes.	8 adradial, peripheral.	2 lateral pouches in tentacular radii. Also an aboral, axial canal extending upward to base of apical sense-organ.	8 simple, uncleft lobes in the tentacular radii.

	Æginura Haeckel, 1879. sens. emend.	Æginopsis Brandt, 1835.	Cunina Eschscholtz, 1829.	Solmissus Haeckel, 1879.	Cunissa Haeckel, 1879.	Æginodiscus Haeckel, 1879.
Equivalent in Haeckel's System der Medusen, 1879, and page-reference to description in his system.	Cunoctona + Æginura, pp. 317, 343.	Æginopsis, p. 342.	Cunina, p. 318.	Solmissus, p. 349. Similar to Cunina but without marginal canals or otoporpæ.	Cunissa + Æginodorus, pp. 322, 344.	Æginodiscus Haeckel, 1879.
Number of tentacles.	8	4	9 or more.		9 or more.	8
Number of peronial strands.	8	8	Equal in number to tentacles.		Equal in number to tentacles.	16
Number and character of primary stomach-pouches in radii of peronial strands.	8, cleft so as to form 16 outer poucbes.	16, as in Æginura.	Simple, uncleft and equal in number to tentacles.		Main lobes are equal in number to tentacles, but are cleft in tentacular radii.	16, cleft so as to give 32 terminal lobes.
Number and character of peripheral lobes of the stomach-pouches.	Tbe 16 stomacb-lobes are sometimes still further bifurcated so that there may be 32 terminal poucbes.	As in Æginura.	Single, simple, uncleft lobe in each tentacular radius.		Terminal lobes twice as numerous as tentacles.	Terminal lobes twice as numerous as peronial strands.

The problematic "Genus" CUNANTHA Haeckel.

Cunina (in part), METSCHNIKOFF, 1870, Gesell. Freunde Naturwissen. Moskau (in Russian), p. 362.
Cunantha, HAECKEL, 1879, Syst. der Medusen, pp. 314, 652.

Haeckel includes three species within this "genus," but the first two (*C. primigenia* and *C. petasoides*) which he describes are apparently very young stages of *Ægina*. The third

medusa (*C. striata*) may possibly be mature (?) and may be considered as the type of the genus. It is probable, however, that *C. striata* is only a young *Ægina*, and the "genus" *Cunantha* is, I believe, only a developmental stage of *Ægina*. No medusa of this "genus" has been described since Haeckel's account in 1879.

GENERIC CHARACTERS.

Æginidæ with 4 tentacles inserted at the distal ends of 4 simple, uncleft, peripheral diverticula of the central stomach.

Cunantha primigenia Haeckel, 1879 (p. 314, taf. 19, fig. 1), and *Cunantha petasoides*, *ibid.*, p. 315, are larval forms of *Ægina*, the species being undetermined. Further information concerning them should be sought for in Haeckel's System der Medusen.

The type species is *Cunantha striata* Haeckel, first described by Metschnikoff, 1870, under the name *Cunina striata*. It is found in the Mediterranean.

The gonads of many Narcomedusæ begin to develop long before the medusa has assumed the features of the mature stage, and this fact has caused considerable confusion in classification, immature stages being described as mature. It is highly probable that both *Cunantha* and *Cunarcha* of Haeckel are only successive developmental stages of *Ægina*.

Cunantha striata Haeckel.

Cunina striata, Metschnikoff, E., 1870, Gesell. Freunde Naturwissen. Moskau, tome 8, p. 362, plate 6, figs. 4–8.
Cunantha striata, Haeckel, 1879, Syst. der Medusen, p. 315.

Bell 12 mm. wide, 8 mm. high, hat-shaped. Margin with 4 wide, almost quadratic lappets, as long as the radius of the central biconvex, lenticular part of the bell. 4 rudimentary tentacles, hardly as long as half the bell-radius, arise a short distance above the margin. 24 sensory-clubs, 6 on each lappet, have each 3 to 4 concretions of entodermal origin. Very long conspicuous, exumbrella sensory tracts, or otoporpæ, above the marginal sense-clubs extend about half-way up the sides of the exumbrella. The exumbrella bears converging radial rows of nettling cells, extending from the margin nearly to the apex. Mouth simple, without œsophagus tube. The 4 radial peripheral stomach-pouches are very small and resemble ordinary radial-canals. The peronial strands are also very short, and thus the tentacles arise at a very short distance above the margin. The gonad forms a simple ring in the lower wall of the stomach-margin.

Found by Haeckel at Villafranca, Mediterranean, in April, 1864. It has not been seen since this time. It is probably only a young *Ægina*.

Genus ÆGINA Eschscholtz, 1829.

Ægina, Eschscholtz, 1829, Syst. der Acalephen, p. 113.—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 53; 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 35, genre A, p. 33; 1904, Bull. du Musée Océanograph., Monaco, No. 5, p. 5; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 69, 70; 1906, Fauna Arctica, Bd. 4, Lfg. 3, pp. 485, 497, Jena.—Vanhöffen, 1908, Narcomedusen *Valdivia* Expedition, p. 47.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool., vol. 37, p. 72.
(?) *Campanella*, Agassiz, A., 1865, North American Acal., p. 52.
Cunantha (in part) + *Cunarcha*, young medusæ + *Ægina* + *Solmundus*, Haeckel, 1879, Syst. der Medusen, pp. 314, 315, 337, 351.
Cunarcha (young medusa), Haeckel, 1881, Report Deep Sea Medusæ, *Challenger* Expedition, Zool., vol. 4, p. 24.
Solmundus + *Ægina*, Vanhöffen, 1907, Zool. Anzeiger, Bd. 32, p. 175.

The type species is *Ægina citrea* Eschscholtz, from the Pacific, 34° N., 201° W. from Greenwich.

GENERIC CHARACTERS.

Æginidæ with 4 to 6 tentacles and 4 to 6 peronial strands. When mature there are 8 to 12 peripheral stomach-pouches which may display cleft margins. The gonads develop in the subumbrella ectoderm of these stomach-pouches. Marginal loop-canals; otoporpæ; secondary, marginal tentacles; peronial furrows; or cruciform lips may or may not be present.

The genus *Cunarcha* and also *Cunoctantha primigenia* Haeckel are specimens of *Ægina* with 4 tentacles and 4 bifurcated peripheral stomach-pouches in the tentacular radii. A later stage is seen when the 8 ends of these 4 bifurcated stomach-pouches become so large that the

medusa has 8 large stomach-pouches, 2 in each intertentacular quadrant. The medusa usually becomes mature in this (*Ægina, sens. str.*) stage, but occasionally each of the 8 main pouches develops a median peripheral notch, thus giving 16 shallow, outer pouches. The peripheral stomach-pouches thus increase by successive bifurcations, commencing with a hypothetical larval stage with only 4 simple pouches in the tentacular radii.

Vanhöffen, 1908, found that one of the Pacific species of *Ægina* usually has 5 tentacles, and that the number ranges from 4 to 6. Bigelow, 1909, found a medusa which he calls *Ægina alternans* which has 4 interradial, marginal stomach-pouches. It is possible that the interradial cleft usually seen has become secondarily obliterated through coalescence of the adjacent pouches, but of this we know nothing.

The genus is thus distinguished chiefly by its having 4 to 6 tentacles and 4 to 6 peronial strands, not by the precise condition of its peripheral stomach-pouches. In common with other Narcomedusæ, the peripheral canal-system is very variable in its development and often degenerates or is wanting. When present, the loop-canals are in the intertentacular sectors, a canal arises from the stomach on either side of each tentacle and extends down on the same side of the peronium to the margin, where it continues through the sector to ascend along the sides of the adjacent peronium and tentacle. In "*Solmundus*" Haeckel there are no peronial canals.

Haeckel widely separates medusæ with otoporpæ from those without these minute, bristle-bearing exumbrella tracts above their sensory-clubs, but this slight difference may probably be best regarded as of specific rather than of generic value.

The peronial furrows are often partially or wholly closed over, leaving the peronial strands buried within the gelatinous substance of the bell.

Maas, 1904, pp. 33, 35, considers *Æginopsis* Brandt, to be an advanced stage of *Ægina* Eschscholtz, basing this opinion upon the more advanced subdivision of the peripheral stomach-pouches of *Æginopsis;* but he appears to overlook the fact that in *Ægina* there are only 4 to 6 peronial strands, whereas in *Æginopsis* there are 8, and the two genera are therefore quite

*Synopsis of the Species of Ægina.**

	Æ. citrea Eschscholtz, 1829= Ægina rosea Eschscholtz.	Æ. rhodina Haeckel = Æ. canariensis Haeckel.	Æ. eschscholtzii Haeckel = Æ. rhodina?
Shape and size of bell in mm.	Hemispherical. 20 to 50 wide.	Pyriform with high apex. 40 to 50 wide, 20 to 30 high.	Rounded. 20 wide, 20 high.
Length of the tentacles in terms of bell-radius (*r*).	2 *r*	2 *r*	*r* –
Number and character of the marginal sense-organs.	2 to 16 in each interperonial quadrant.	4 to 10 in each interperonial quadrant.	?
Character of mouth.	A simple, round opening.	A simple, round opening.	4 long, triangular lips.
Character of stomach-pouches.	8 cleft so that there are 16 shallow peripheral lobes. 8 main pouches are adradial and extend about half the distance from central stomach to bell-margin.	8 with entire uncleft outer edges. Pouches extend less than half the distance from central stomach to bell-margin.	8 simple, with entire outer edges, as in Æ. rhodina.
Peronial loop-canals.	Present. Canals well developed.	Present. Canals well-developed.	Present.
Gonads.	Under peripheral parts of stomach-pouches.	Under entire areas of 8 stomach-pouches.	As in Æ. rhodina.
Color.	Entoderm of stomach and tentacles citron-yellow or rose-red.	Tentacles red. Stomach and gonads red or green.	?
Where found.	Tropical Pacific. Often near surface.	Tropical Atlantic. Often found at or near surface.	Azores, Atlantic.

*Species of *Ægina* known only from immature specimens are not recorded in this table. For references to these, see text. For *Ægina brunnea* and *Æ. alternans* see text.

distinct and can not be merged. *Æginopsis* is probably derived from *Æginura* by the reduction of half of its tentacles and bears the same relation to *Æginura* that *Solmundella* does to *Ægina*.

Maas, however, proposes a classification which avoids the minute distinctions of Haeckel's system, and his arrangement is far simpler and more convenient.

A genus may be looked upon as a somewhat crudely gathered collection of near blood-relatives, and their general relationship is often rendered more apparent by permitting them all to remain under one broad designation than by subdividing them upon a basis of slight distinctions, thus obscuring the fact of their relationship. Systematic zoology will be better advanced by a classification which *indicates relationships*, rather than by one which points out distinctions, and Haeckel's system, ingenious as it always is, is artificial in that it often widely separates forms which are actually closely related.

Cunarcha Haeckel is probably a larval stage of *Ægina*, wherein the 4 primary stomach-pouches are not yet cleft by the insertion-roots of the tentacles. *Cunarcha* bears the same relation to *Ægina* as *Cunoctona* does to *Æginura*.

Ægina citrea Eschscholtz.

Ægina citrea+*Ægina rosea*, Eschscholtz, 1829, Syst. der Acalephen, pp. 113, 115, taf. 10, fig. 3; taf. 11, fig. 4.
Ægina rosea+*Ægina citrea*, Haeckel, 1879, Syst. der Medusen, p. 338.
Ægina citrea, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, p. 71, taf. 11, fig. 72; taf. 13, fign. 79-82.—Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 73, plates 1, 14.—Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 50.

Bell 20 to 50 mm. wide, hemispherical, gelatinous substance thick at apex but very thin at margin. 4 stiff, tapering tentacles, about as long as bell-diameter, project from the sides of bell in a zone about midway between margin and apex. A deep, radial furrow extends up from bell-margin to base of tentacle; its bottom is lined by a thickened mass of ectoderm, containing nematocysts, called the peronium. This peronial strand becomes considerably swollen immediately under the base of each tentacle forming a cushion-like support for the latter. Tentacles solid, their entoderm consisting of vacuolated chordate cells continuous with the entoderm of the stomach.

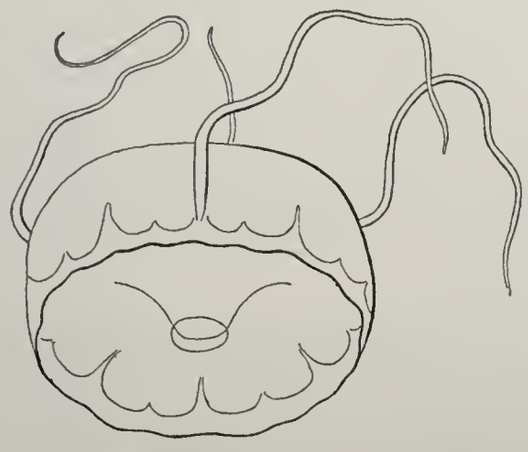


Fig. 299.—*Ægina citrea*, after Eschscholtz, 1829.

There are typically 8 marginal sensory-clubs, 2 in each quadrant between tentacles, but Vanhöffen records 16 in one quadrant. Velum well-developed with powerful circular muscles. Stomach wide, flat, lenticular, its periphery giving rise to 8 radiating pouches, 2 between each pair of tentacles. These pouches are rectangular with rounded angles and are nearly as long as radius of central part of lenticular stomach. The 8 pouches are separated one from another by 8 long, narrow clefts and there is a small notch at the middle of the outer edge of each lappet. Mouth simple, circular. The peripheral canal-system consists of 4 separate loops, each loop being composed of a narrow vessel, extending outward from the edge of the stomach on one side of a tentacle and then down on the same side of a peronium, then along a quadrant of the margin, to ascend along the side of another peronium and to reenter the stomach on the adjacent side of a tentacle 90° away from its place of origin. The gonads are developed in the ectoderm of the subumbrella wall of the stomach around the peripheral parts of the stomach-pouches.

The entoderm of the stomach and its pouches are citron-yellow or rose-red. Many Trachymedusæ and Narcomedusæ are greenish by reflected, and red by transmitted, light and this may account for the differing descriptions of its color.

Found in the tropical Pacific.

Vanhöffen, 1908 (Narcomedusen der *Valdivia* Expedition, p. 48, taf. 1 and 3), records the capture of 19 specimens of an *Ægina* in the tropical Atlantic and Indian Oceans between depths of 2,000 fathoms and the surface. He calls this medusa *Ægina rosea*, but it lacks the

secondary clefts of the stomach-pouches and there are about 100 sense-clubs. Moreover 14 of Vanhöffen's specimens had 5, and only 4 had 4 tentacles and peronial strands. The tentacles and stomach are pink or rose-red. Mouth a round opening. The marginal canal-system is well developed. This medusa was most abundant at depths between 1,000 and 2,000 fathoms.

Vanhöffen maintains that *Ægina rosea* is specificially distinct from *Æ. citrea*, and certainly his observations recorded above appear to give substantial support to his contention, but in view of our imperfect knowledge of the development and range of variability of the species of *Ægina* I prefer to suspend judgment upon the point.

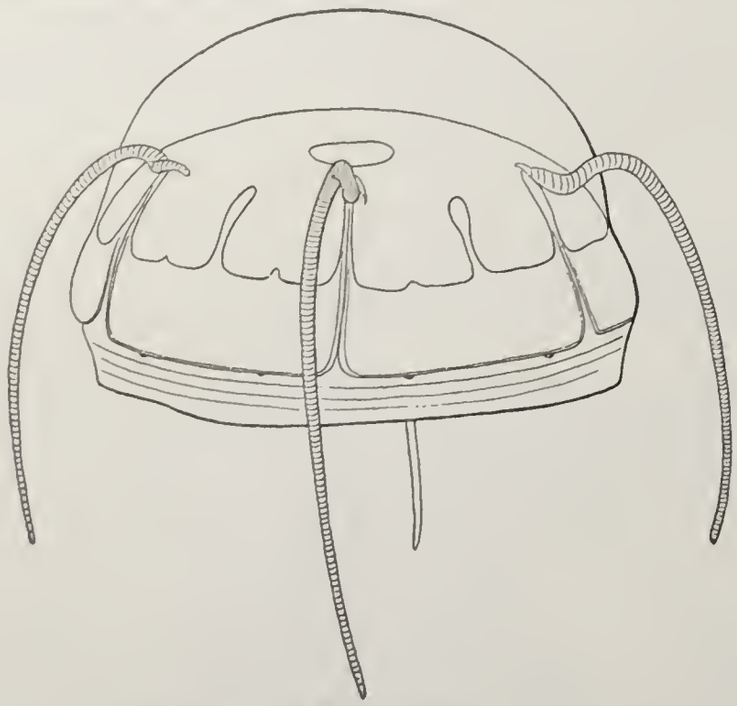


FIG. 300.—*Ægina citrea*, after Maas, in Hydromedusen *Siboga* Expedition.

Ægina rhodina Haeckel.

Plate 52, fig. 5; plate 54, figs. 11—11.'''

Ægina rhodina, HAECKEL, 1879, Syst. der Medusen, p. 338, taf. 20, fign. 11-15.—MAYER, 1904, Mem. Nat. Sci. Brooklyn Inst. Arts. and Sci., vol. 1, p. 27, plate 4, figs. 28, 29.—MAAS, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 71.
Ægina canariensis (young medusa?), HAECKEL, Syst. der Medusen, p. 339.
Solmundus tetralinus (young medusa?), HAECKEL, 1879, Syst. der Medusen, p. 351, taf. 19, fig. 10.
Ægina canariensis, MAAS, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 53.
(?)*Ægina lactea*, VANHÖFFEN, 1908, Narcomedusen der *Valdivia* Expedition, p. 50, taf. 1, fig. 3.

Haeckel describes a mature medusa 40 to 50 mm. wide and two small "species," one 10 mm. wide, which he calls *Ægina canariensis*, and another 4 mm. wide, called *Solmundus tetralinus*. They appear to be only stages in the growth of the same medusa, as will appear from the tabulation of their characters, on the following page, as stated by Haeckel.

These medusæ were found by Haeckel in the Canary Islands. All have a simple, round mouth-opening and the gelatinous substance of the bell projects downward in the form of a wide cone into the stomach-space. Haeckel cut no sections and his statement that there is no peripheral canal-system in "*Solmundus tetralinus*" requires confirmation for it is well developed in *Æ. rhodina*.

I found a medusa at Mastic Point, Andros Island, Bahamas, which appears to be *Ægina rhodina*. It is apparently intermediate between the "*tetralinus*" and *canariensis* stages of Haeckel. The bell was 7 mm. wide and there were 12 marginal sense-clubs, 3 upon each interperonial quadrant. There were no ripe gonads. The stomach was intense green, but the tentacles were pink. Green and red are often found interchangeably in the same species of *Ægina*. Maas, 1893, records "*Ægina canariensis*" from off the African coast in about lat. 12° N., south of the Cape Verde Islands.

Growth-stages in the Development of Ægina rhodina.

	"Solmundus tetralinus" Haeckel.	"Aegina canariensis" Haeckel.	Ægina rhodina Haeckel.
Size of bell in mm.	4 high, 4 wide.	4 high, 10 wide.	20 to 30 high, 40 to 50 wide.
Shape and size of the 8 stomach-pouches.	Small, quadratic, with rounded edges.	Twice as wide as long, with rounded edges, extending to near the bell-margin.	Quadratic, separated by small intervals. Not half as long as distance between periphery of central stomach and bell-margin.
Length of 4 tentacles in terms of bell-radius (*r*)	4 *r*	4 *r*	2 *r*
Number of marginal sense-clubs.	8	16	16
Color.	?	Stomach, gonads, and tentacles rose-red.	Stomach light-red. Gonads and tentacles rose-red.
Gonads.	? (Not seen.)	Present.	Present.

Ægina rhodina is probably widely distributed over the tropical Atlantic, but appears to be rarer off the American coast than it is off the coast of Africa. It is, however, abundant at times in the Gulf Stream off the Florida coast.

Further details of the mature medusa are given in the table, showing a synopsis of the species of *Ægina* on page 450.

Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 50, taf. 1, fig. 3, records the capture of a medusa which he calls *Ægina lactea* in the South Atlantic off the African coast between the mouth of the Congo and Great Fish Bay from a depth of 350 to 500 fathoms. It has 4 tentacles, 8 simple, gastric pouches, and 10 sensory-clubs per quadrant. The bell is 11 mm. wide and 8 high. The only distinctive features, however, are the white, milky-colored stomach-pouches and flesh-colored tentacles; but the coloration of species of *Ægina* seems to be highly variable, and I can not be sure that this medusa is not merely a variety of *Ægina rhodina*. I believe, indeed, that future studies will probably show that the Atlantic *Æ. rhodina* is specifically identical with the Pacific *Æ. citrea*.

Ægina eschscholtzii Haeckel.

Ægina eschscholtzii, Haeckel, 1879, Syst. der Medusen, p. 339.

Bell 20 mm. wide, 20 mm. high, rounded. 4 tentacles not quite as long as bell-radius. Marginal sensory-clubs (?) Stomach with a wide, conical, gelatinous plug, extending downward into its cavity, as in *Æ. rhodina*. Mouth at end of a conical neck and provided with 4 large, triangular lips. 8 quadratic genital pouches, somewhat longer than wide. Found at the Azores, Atlantic Ocean. One specimen out of the 4 found had 5 lips, 5 tentacles, and 10 genital sacs. This species is distinguished solely by its having 4 or 5 lips instead of a circular mouth-opening.

Ægina brunnea Vanhöffen.

Ægina brunnea, Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 51, taf. 1, fig. 4.

This medusa resembles *Æ. rhodina* but the stomach-pouches are mottled with brown and the tentacles and peronia are white. A single specimen 10 mm. wide was found in the Indian Ocean from a depth of 1,000 fathoms, in the North Equatorial Stream.

Ægina alternans Bigelow.

Ægina alternans, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 74, plate 17, fig. 1.

Bell 40 mm. wide, high, rounded. Exumbrella smooth. 4 tentacles as long as bell-diameter. At least 2 sensory-clubs per quadrant. There are only 4 interradial, marginal stomach-pouches without any trace of interradial notches, but the radial notches adjacent to the peronia are very deep. Thus we find in this medusa only 4 simple stomach-pouches alter-

nating in position with the 4 peronia and tentacles. Gonads (?) Medusa colorless. A single specimen from between 2,235 fathoms and the surface off the coast of Peru to Equador, South America. Apparently immature.

Young medusa: Ægina æginoides.

Cunarcha æginoides, Haeckel, 1879, Syst. der Medusen, p. 315; 1881, Report on Deep-sea Medusæ, *Challenger* Expedition, p. 24, plate 9, figs. 1–8.

Immature medusa.—Bell flat, cup-shaped, 4 mm. wide, 2 mm. high. A deep, coronal furrow separates the thick, upper, flatly dome-shaped apex of the bell from the thin, lappeted margin. 4 stiff tentacles, about as long as bell-diameter, arise from the coronal furrow, and their roots are inserted into the gelatinous substance above the central stomach. Their entodermal cores consist of a single row of vacuolated, chordate cells. The distal ends of the tentacles are club-shaped and bear long bristles. There are 4 peronial furrows in the radii of the 4 tentacles and an urticating ring extends out from these around the margins of the 4 lappets. There are 12 sensory-clubs, 3 on the margin of each lappet. The median club of each quadrant is about twice as large as the two that flank it. Each club contains a single crystalline concretion of entodermal origin. The club arises from a ciliated cushion and above this is a very large sensory tract, or otoporpa, extending up the exumbrella side of the lappet. The otoporpa of the median sense-club extends almost half the distance from the margin toward the coronal furrow. Velum wide. Stomach elongate, conical, with 4 lips. The mouth projects beyond the velar opening. The central stomach gives rise to 4 main radial pouches in the radii of the 4 tentacles. These 4 main pouches are deeply cleft in the 4 intertentacular radii and also by the roots of the tentacles, so that there are 8 outermost stomach-pouches. The gonads are developed in the subumbrella ectoderm of the 8 peripheral stomach-pouches. The medusa is colorless.

Found at the Canary Islands, off the west coast of Africa and south of the Azores.

Haeckel states that a peripheral, peronial canal-system is present, but his figures of cross-sections do not appear to show this, and that which he describes as a marginal canal seems to be merely the distal end of a stomach-pouch. This medusa shows every evidence of immaturity and may be regarded as a young *Ægina*.

Cunantha primigenia Haeckel, 1879 (p. 314, taf. 19, fig. 1), is a still younger stage of *Ægina*, with only 4 sensory-clubs and with the gonads only beginning to appear in the 4 interradii of the stomach. In other respects it so closely resembles *Ægina æginoides* that one is inclined to believe that it may be an early stage of the latter.

Genus SOLMUNDELLA Haeckel, sens. Maas.

Non Æginopsis, Brandt, 1835, Prodrom. Descript. Anim. Mertens, p. 22.—Haeckel, 1879, Syst. der Medusen, p. 342.

Æginella + Solmundella, Haeckel, 1879, Syst. der Medusen, pp. 340, 349, 352.

Æginopsis, Müller, J., 1851, Archiv. für Anat. und Physiol., pp. 272, 277.—Kölliker, 1853, Zeit. für wissen. Zool., Bd. 4, p. 320.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 266.—Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 33.—Metschnikoff, 1874, Zeit. für wissen. Zool., Bd. 24, p. 26.—Hertwig, O. und R., 1878, Sinnesorgane und Nervensyst. der Medusen, pp. 11, 17, 33 (histology).—Graffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 360.—Metschnikoff, 1886, Embryolog. Studien an Medusen, Wien, pp. 23, 35, 62, 100.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 53.

Æginella, preoccupied for Crustacea by Krüyer, 1838.

Æginella, Agassiz and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 166; Mayer, *Ibid.*, 1900, vol. 37, p. 66.—Bigelow, 1904, *Ibid.*, vol. 39, p. 261.

Campanella (in part), de Blainville, 1834, Man. d'Actinologie, p. 286.

Campanella, preoccupied by Goldfuss, 1820, for Infusoria.

Campanella, Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, pp. 169, 170.

Non Campanella, Lesson, 1843, Hist. Zooph. Acal., p. 281.—Agassiz, A., 1865, North Amer. Acal., p. 52.

Solmundella, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 54; *Ibid.*, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 69, 72; 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 34; 1906, Expédition Antarctique S. Y. *Belgica*, Medusen, p. 11, Anvers.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 741; *Ibid.*, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Suppl. Report 27, p. 153.—Wolterfeck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Vers., pp. 106, 113.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 497; 1906, Revue Suisse de Zool., tome 14, p. 99; 1904, Bull. Musée Océanograph., Monaco, No. 5, p. 4.—Vanhöffen, 1907, Zool. Anzeiger, Bd. 32, p. 176; Narcomedusen der *Valdivia* Expedition, p. 45.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 75.

The type species is *Solmundella bitentaculata* of the tropical Atlantic and Pacific. This was originally described by Quoy and Gaimard, 1833, under the name of *Charybdea bitentaculata*.

GENERIC CHARACTERS.

Æginidæ with only 2 functional, diametrically opposite tentacles. With 4 radial furrows and peronia. The central stomach gives rise to 8 peripheral outpocketings, 2 in each quadrant, between the radial furrows. No peripheral, gastrovascular canals.

The generic name *Campanella* of de Blainville, 1834, was applied to Eucopidæ as well as to our *Solmundella*, and its future use by authors was so confusing that it seems impossible to attach any definite significance to the name. Moreover, it was preoccupied for *Infusoria* by Goldfuss, 1820, so that it must lapse into the list of obsolete genera among medusæ. Haeckel, 1879, first defined *Solmundella* in the sense in which we have accepted it; but he also instituted another genus "*Æginella*" resembling *Solmundella*, but with a peripheral canal-system. The brothers Hertwig, Maas, Browne, Vanhöffen, and the author have sectioned these medusæ and have demonstrated that there are no peronial or ring-canals, hence the genus "*Æginella*" is identical with *Solmundella*.

The genus *Æginopsis* Brandt has been used by older authors to designate our *Solmundella*, but Brandt founded *Æginopsis* for a medusa with 4 tentacles, 8 double, peronial strands, and 16 radiating stomach-pouches; and it therefore differs widely from *Solmundella*. (See text-fig. 309*a*.)

There appear to be but two forms of *Solmundella* and these are probably only varieties one of the other. Both are of world-wide distribution near the surface over all tropical oceans. As they develop directly through actinulæ and the larvæ are free-swimming, they are found far out in the midst of the ocean, being in no sense dependent upon land. The development is discussed in detail under *Solmundella mediterranea*.

The following table will serve to exhibit the distinctions between these two forms:

Synopsis of the Two Varieties of Solmundella.

	S. bitentaculata.	S. mediterranea.
Shape and size of bell when mature. Dimensions in mm.	12 to 15 mm. wide, crest of bell keel-like and tentacular, diameter longer than intertentacular diameter. Edge of keel-shaped apex of bell in tentacular axis.	4 to 6 mm. wide. Radially symmetrical, tentacular and intertentacular diameter being equal each to each. Apex of bell dome-like, evenly rounded.
Length of the 2 long tentacles in mm.	100	10 to 18
Character of 4 peronial furrows.	2 furrows in radii of long tentacles very deep, while the two furrows 90° away from former partially closed over, so that peronial strands are sunken in gelatinous substance of bell.	The 4 peronial furrows all open, and peronial strands lie at bottom, and not sunken within gelatinous substance of bell.
Where found.	Tropical Atlantic, Indian, Pacific, and Antarctic Oceans, (Mediterranean ?).	Mediterranean, tropical Atlantic, Pacific, Antarctic, and Indian Oceans.

Solmundella bitentaculata Browne.

Charybdea bitentaculata, Quoy et Gaimard, 1833, Voyage de l'*Astrolabe*, tome 4, p. 295, planche 25, figs. 4 and 5.
Æginella bitentaculata, Haeckel, 1879, Syst. der Medusen, p. 341.
Solmundella hensenii (*Æginopsis hensenii*), Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K.c., p. 55, taf. 5, fig. 11.
Solmundella bitentaculata, Maas, 1906, Revue Suisse Zool., tome 4, p. 99.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 73, taf. 11, fig. 74; taf. 12, fig. 75; taf. 13, fign. 86–89.—Browne, 1904, Fauna and Geog. Maldive and Laccadive Archipelagoes, vol. 2, p. 741, plate 56, fig. 3; *Ibid.*, 1905, Report on Pearl Oyster Fisheries, Gulf of Manaar, Roy. Soc. London, Suppl. Report No. 27, p. 153, plate 4, figs. 1–6.—Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 45, taf. 3, fign. 11–15; Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 77, plate 2, fig. 3.

Bell 12 to 15 mm. wide, 10 to 12 mm. high, gelatinous substance thick; apex of bell sharp-edged and keel-shaped, the line of the keel being in the axis of the two long tentacles. Bell wider in axis of keel and tentacles than in the diameter 90° from this. The 2 tapering tentacles project from the sides of bell at a zone nearer to apex than to margin; they are 50 to

100 mm. long, both being of equal length. Their entodermal cells form an axial row and are highly vacuolated and continuous with the entoderm of the stomach. The entoderm on the axial and abaxial sides of the tentacles is developed into powerful strands of longitudinal muscles, serving to sweep the tentacles to and fro in an oar-like manner. After penetrating the gelatinous substances of the bell, the root of each tentacle bends centripetally inward.

A deep, narrow, peronial groove extends upward along the side of the exumbrella from the velar margin to the base of each tentacle. At the bottom of this groove there is a thick strand of ectoderm, which is continuous with the ectoderm of the tentacle and unites at the base of the latter with the ectoderm of the subumbrella. The peronial strands 90° away from the tentacular radii are not at the bottom of open furrows, but are covered over on the abaxial side by the gelatinous substance of the bell, so that there are no furrows excepting in the radii of the tentacles, and only a slight notch at the margin in the radii 90° away from the tentacles, the exumbrella surface being smooth and entire over the *non-tentacular* peronia. There are usually a few wart-like thickenings at intervals around the margin and these projections are best developed in the 4 interradii, alternating with the 4 peronia. They are probably vestigial tentacles and are not always present.

There are sometimes as many as 32 sensory-clubs, 8 per quadrant, although there are usually only about 8 to 16. They are mounted upon very slender stalks and each contains a single, spherical concretion. At the base of the club is a swollen cluster of sensory cells bearing long, hair-like bristles. There are no sensory tracts over the exumbrella above the clubs. Velum well developed, with powerful circular muscles. There is a niche-like infolding of the ectodermal wall of the subumbrella under the bases of the 2 functional tentacles.

Central stomach quite flat and lenticular, the mouth being a simple round opening. This central stomach gives rise to 8 radiating outpocketings, 2 between each successive pair of peronial strands. These are almost rectangular with rounded angles and extend outward about half-way from the periphery of the central stomach to the margin. The gonads are developed in the ectodermal wall of the subumbrella under the 8 stomach-pouches, and in large medusæ they occur under the entire areas of the pouches and also form a continuous ring near the periphery of the central stomach.

The entoderm of the central stomach, pouches, and tentacles is either green or red, but is very variable, some specimens being nearly colorless or milky. Green appears by reflected, and red by transmitted, light.

This variety is widely distributed over the tropical Atlantic, Pacific, Antarctic (Vanhöffen), and Indian Oceans. Apparently it has not been taken in the Mediterranean. I have found it at Tortugas, Florida, in July. (See text-figure 301.)

The best descriptions are those of Browne, 1904, Maas, 1905, Vanhöffen, 1908, and Bigelow, 1909.

Vanhöffen, 1908, reports the finding by the *Valdivia* of 7 specimens of this medusa, or of its variety *mediterranea*, from which he does not distinguish it, among icebergs in the Antarctic Ocean. As he states, *Solmundella* is the most widely distributed Narcomedusa known, ranging from the North Atlantic through the tropical Pacific and Indian Oceans to the Antarctic. Living at temperatures of 27° to −1° C, and in depths ranging from 1,500 fathoms to the surface.

Solmundella bitentaculata var. mediterranea Haeckel.

Plate 54, figs. 1 to 3; plate 55, fig. 4.

Æginopsis mediterranea, Müller, J., 1851, Archiv. für Anat. und Physiol., p. 272, taf. 11 (development).—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 266.—Leuchart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 33, taf. 2, figs. 8, 9.—Metschnikoff, E., 1874, Zeit. für wissen. Zool., Bd. 24, p. 26, taf. 4, fign. 17–22 (development); 1886, Embryolog. Studien an Medusen, Wien, pp. 23 (egg), 35 (segmentation), 62 (formation of entoderm), 100 (actinula larva), taf. 9, fign. 1–30.

Solmundella mediterranea, Haeckel, 1879, Syst. der Medusen, pp. 309, 348, 352; *Ibid.*, *S. mülleri*, p. 352.—Dawydoff, 1907, Zool. Anzeiger, Bd. 31, p. 119, 3 fign. (mesoderm of larva).

Æginopsis mediterranea, Graeffe, 1884, Arbeit. Zool. Inst. Wien, Bd. 5, p. 360.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 54, fign. 1, 2 (development); 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 73, 75.—Woltereck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Vers., p. 113, fig. 9, (? fig. 11) (development).—Maas, 1906, Expédition Antarctique, S. Y. *Belgica*, Medusen, p. 12, taf. 1, fig. 5; taf. 3, fign. 23, 24 (medusa from the Antarctic Ocean).

Æginella dissonema, Haeckel, 1879, Syst. der Medusen, p. 340, taf. 20, fig. 16.—Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 166.—Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 66, plate 14, figs. 30 to 32.—Bigelow, H. B., 1904, Bull. Mus. Comp. Zool. at Harvard College, vol. 39, p. 261.

Plate 54.

Figs. 1 to 3. *Solmundella mediterranea.* Figure 1, oral view of the medusa; figure 2, sensory-club; figure 3, optical section of a portion of the length of a tentacle. A side-view of this medusa is shown in figure 4, plate 55.

Fig. 4. *Cunoctantha kollikeri.* A budding stolon-larva found floating at Tortugas, Florida, July, 1904. (See page 464.)

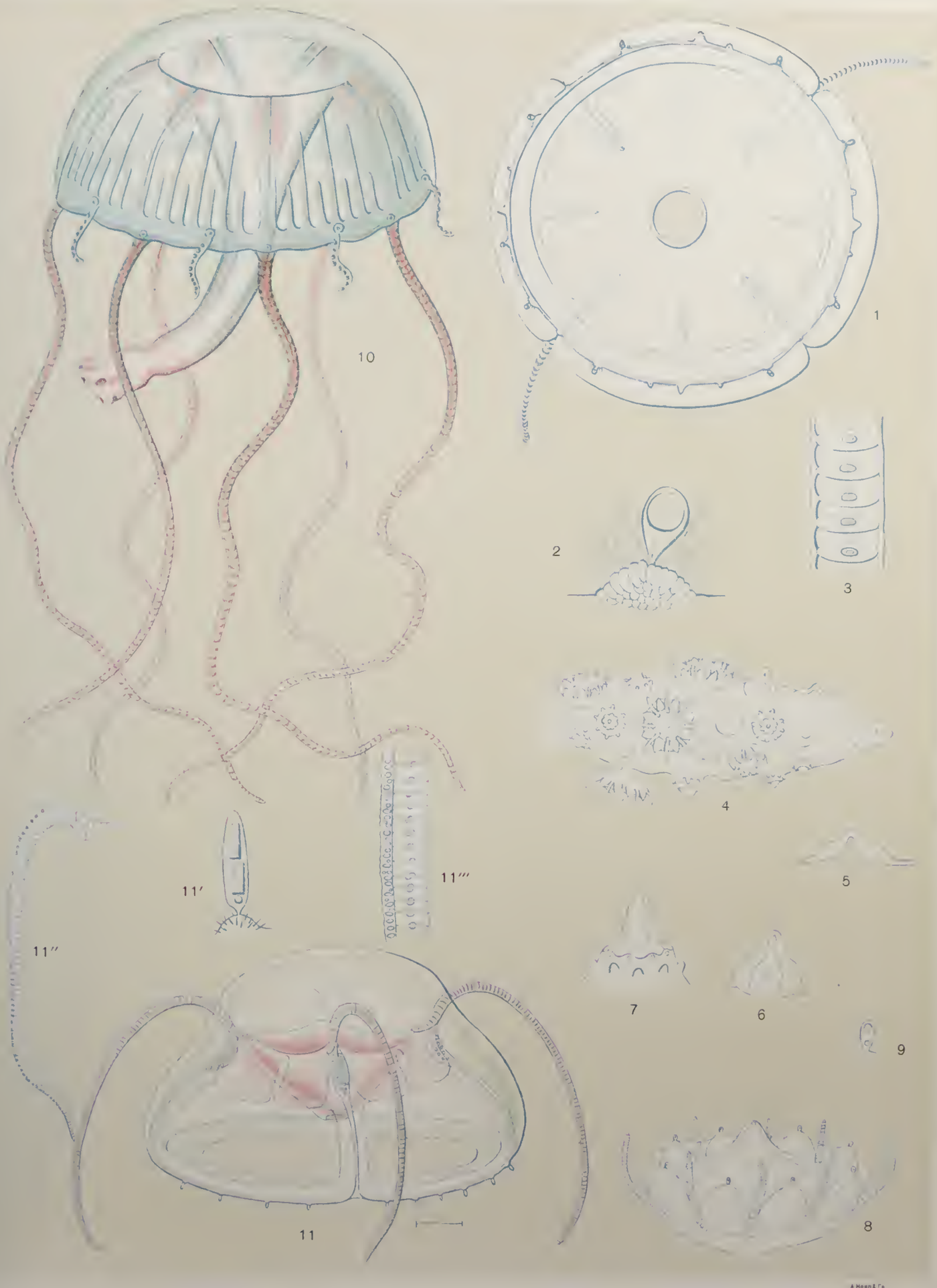
Figs. 5 to 8. *Cunoctantha kollikeri*(?) Successive stages in the development of the medusa-buds on the stolon-larva shown in figure 4.

Fig. 9. *Cunoctantha kollikeri*(?) Sensory-club of the medusa-bud shown in figure 8.

Fig. 10. *Geryonia proboscidalis*, with contracted manubrium. Drawing twice the natural size. Nassau Harbor, Bahamas, April, 1907. (See page 425.)

Figs. 11 to 11‴. *Ægina rhodina.* Tongue of the Ocean, north of Nassau, Bahamas, April 21, 1907. Figure 11′, one of the marginal sensory-clubs; figure 11″, one of the tentacles; figure 11‴, optical section near the middle of the length of one of the tentacles showing the abaxial ridge of nettling cells which extends along the outer side of the tentacle. (See page 452.)

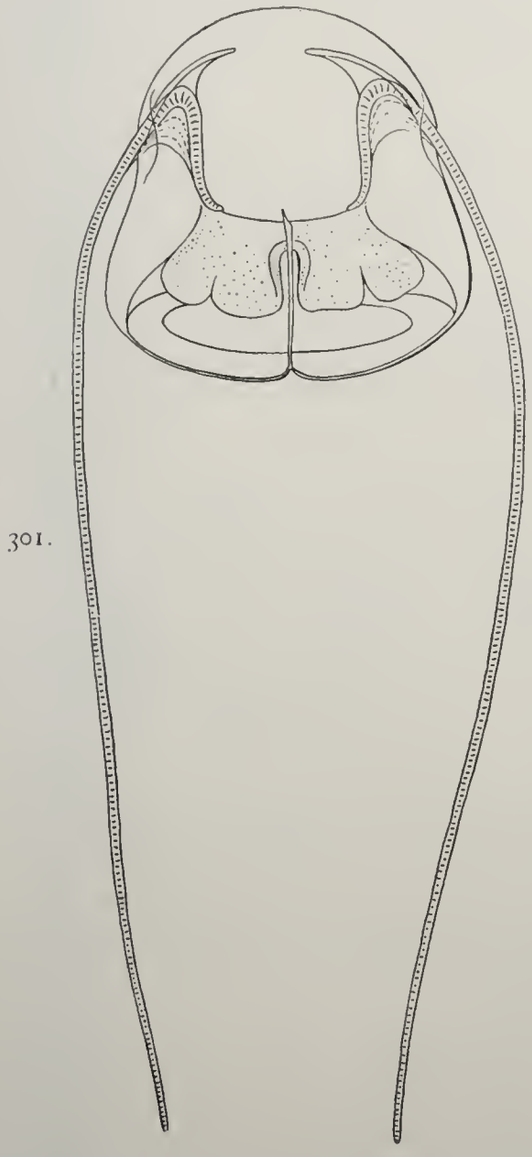
Figure 11 drawn by Mr. Carl Kellner; other figures drawn from life, by the author.



A Hoen & Co

I am inclined to consider this as identical with the somewhat larger *S. bitentaculata*, or at most only an ill-defined variety of the latter.

S. mediterranea, however, becomes mature when the bell is only 3 to 6 mm. wide, whereas, according to Maas (1905, p. 75), *S. bitentaculata* shows no trace of gonads even when 8 mm. wide. The largest *S. mediterranea* are not more than 6 mm. wide, whereas *S. bitentaculata* becomes 12 to 15 mm. wide. Moreover, according to Maas, 1893, 1905, the apex of the bell in *S. bitentaculata* is sharp-edged and keel-like, being laterally flattened and elongated in the axis of the 2 long tentacles. The apex of the bell of *S. mediterranea* is, on the other hand, simply dome-like and rounded. According to Maas, 1893, 1905, the outline of the bell-margin of *S. bitentaculata* is elliptical and elongated in the tentacular axis, whereas the outline of the margin of *S. mediterranea* is circular. In *S. bitentaculata* the intertentacular peronial strands



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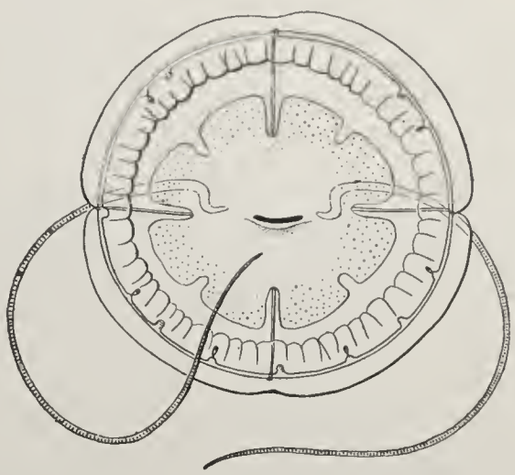


302.

Fig. 301.—*Solmundella bitentaculata*, Tortugas, Florida, 1907, from life, by the author.

Fig. 302.—*Solmundella bitentaculata* var. *mediterranea*, oral view. From life, by the author, Naples Zoological Station, February 1, 1908.

are buried in the gelatinous substance of the bell, and this is also true of *S. mediterranea*; but in some specimens of *S. mediterranea* they are at the bottom of open or partially open furrows, as are the tentacular peronia in both species. There are as many as 32 marginal sense-clubs in *S. bitentaculata*, but apparently never more than 16 in *S. mediterranea*.

There are occasionally a few very small vestigial tentacles on the bell-margin of *S. mediterranea*. These are merely minute projections and may be at the margin in the radii of the intertentacular furrows or in one or more of the 4 interradii. They are often entirely absent and are usually irregular in development and position when present.

The color of *S. mediterranea* is very variable. Some specimens are nearly colorless, the stomach and tentacles being slightly milky or yellow. Others show these parts intense yellow-green by reflected, or red by transmitted, light.

S. mediterranea is widely distributed, although rarely very common, except in the Mediterranean, where it is abundant. It is found in the tropical Atlantic, Pacific, and Indian Oceans, and in the Mediterranean. I have figured it in the Fiji Islands, South Pacific, and at Tortugas, Florida, and can detect no specific differences between specimens from these widely-separated places. The medusa appears in small swarms at or near the surface. Maas, 1906, records this medusa from the Antarctic Ocean, about S. lat. 70°, W. long. 80° to 90°.

The development has been studied by J. Müller, Metschnikoff, Maas, and Woltereck. The medusa develops directly from an actinula larva, each egg developing into a single medusa. According to Metschnikoff, 1886, the egg is 0.23 mm. in diameter and is cast out into the water between 5 and 6 in the afternoon from February to December, in the Mediterranean. Segmentation is total and equal until the 16-cell stage is reached; then the entoderm is formed by multipolar ingression. Cells migrate into the interior from any point whatsoever, and these soon fill up the central segmentation cavity and form the entoderm. The larva then elongates and the ectoderm becomes ciliated. Soon the elongation becomes so great that the larva resembles a detached tentacle of some hydroid, it is so very long and spindle-shaped. The entodermal cells of both ends are disk-like and set in a single row, while in the center the entoderm forms a parenchyma-like mass. The 2 elongated ends become the tentacles and the center develops into the body of the actinula larva. The actinula is at first miter-shaped, with two long, stiff, filiform tentacles 108° apart. The entoderm of the body then consists of a mass of vacuolated cells and is entirely incased by the ectoderm. Later the mouth breaks through and the central stomach-cavity develops, lined by a single layer of entodermal cells. At first there is no gelatinous substance between ectoderm and entoderm, but this begins to form above the stomach and is probably secreted by the entoderm. It forms a thick, lenticular mass between the ectoderm and entoderm. No peripheral canals or ring-canal are developed. The bell-walls grow out from the sides of the larva *after* the tentacles and central stomach have developed.

Woltereck finds that when the actinula larva has a pair of tentacles and has developed its mouth, although as yet there is no gelatinous substance, there is a cluster of elongated, cylindrical, epithelial cells at the aboral pole of the larva and these bear long cilia. He found these cells persisting in a young medusa with well-developed bell and with its gelatinous substance well formed, which was dredged from deep water off Villafranche, Mediterranean. Woltereck finds also that there is a well-developed, ciliated, aboral pole-plate encircled by a ring-like ridge in the actinula larva of Tubularia. No trace of an aboral sense-organ has been seen in adult specimens of *Solmundella bitentaculata* or *S. mediterranea*, but it will be recalled that a pair of apical lithocyst-clubs are described by Dawydoff in his remarkable form *Hydroctena*. The actinula larva of *Solmundella* is transformed into the medusa by the growing out of the bell from the sides of the larva, and it is interesting to observe that the tentacles of the medusa are those of the *Actinula* and are formed *long before* the bell begins to develop. *Solmundella* may be regarded as a medusiform actinula and its bell is not homologous with the bell of the Anthomedusæ and Leptomedusæ. The medusa-shape has probably been acquired independently in *Trachylina* and in *Leptolina* medusæ.

Genus HYDROCTENA Dawydoff, 1903.

Hydroctena, Dawydoff, 1903, Zool. Anzeiger, Jahrg. 27, p. 223; 1903, Mém. Acad. Inipériale des Sci. St. Pétersbourg, sér. 8, vol. 14, No. 9.
Hydractena, Woltereck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Jahresvers., p. 115: Zool. Anzeiger, Jahrg. 28, 1904.

The type species and only representative of the genus is *Hydroctena salenskii*, described by Dawydoff from the Malay Archipelago. Dawydoff is the only student who has observed this remarkable medusa.

GENERIC CHARACTERS.

Narcomedusæ with an apical sense-organ consisting of sensory-clubs and ciliated ectodermal epithelium and with 2 diametrically opposite tentacles arising from sheath-like sockets in the sides of the bell. The axial cores of these tentacles are said to consist of gelatinous

substance continuous with that of the bell, and not of chordate entoderm as in other Narcomedusæ. There is no peripheral canal-system. Neither marginal tentacles nor marginal sense-organs of any sort.

In all respects, excepting its apical sense-organ, peculiar structure of the tentacles, and in the absence of marginal sense-organs, this genus resembles *Solmundella*. This resemblance is rendered closer by the recent discovery by Woltereck, 1904–05, that the larva of *Solmundella* has a ciliated, apical pole-plate.

The gonads of *Hydroctena* have not been observed and the specimens found by Dawydoff were apparently immature.

The resemblance between *Hydroctena* and *Ctenophoræ* appear to me to be merely parallelisms, none of which indicate a genetic relationship with Ctenophoræ. The only exclusively Ctenophore-like character of *Hydroctena* is the gelatinous nature of the axial cores of its tentacles, which differ from those of other Narcomedusæ in being highly contractile.

Hydroctena salenskii Dawydoff.

Hydroctena salenskii, Dawydoff, 1903, Zool. Anzeiger, Bd. 27, pp. 223–226, 3 fign.; 1903, Mém. Acad. Impériale des Sci. St. Pétersbourg, sér. 8, vol. 14, No. 9, 15 pp., 1 taf., 11 fign.—Maas, 1904, Zool. Centralbl., Bd. 11, p. 240; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 75.—Schneider, 1904, Zool. Anzeiger, Bd. 27, p. 569.
Hydractena, Woltereck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Jahresvers., p. 115.

Immature medusa.—Bell pyriform, 4 mm. high. No tentacles or sense-organs at bell-margin, but instead 2 long, diametrically opposed tentacles arise from deep sockets in the sides of bell and project from the exumbrella nearer to apex than to bell-margin. The tentacles are simple and lack lateral filaments, highly contractile, and can be partially withdrawn

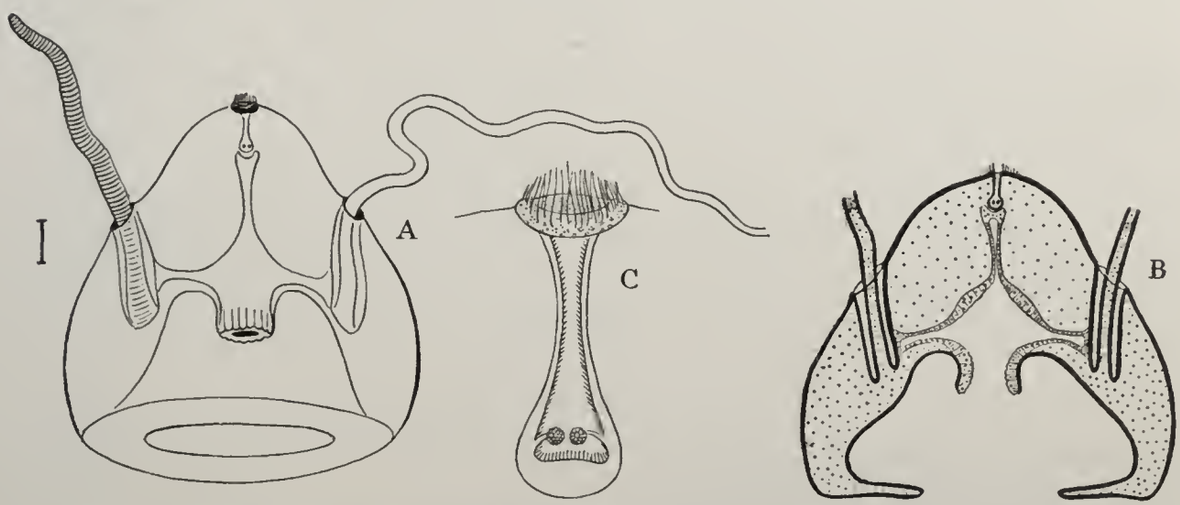


Fig. 303.—*Hydroctena salenskii*, copied from Dawydoff, in Mém. Acad. Sci. St. Petérsbourg. *A*, side view of medusa; *B*, saggital section; *C*, view of apical sense-organ.

within their pit-like sheaths. Their ectoderm contains nematocysts similar to those of Hydromedusæ, but their axial cores do not consist of entodermal cells but of the gelatinous substance (mesogloea) of the bell as in Ctenophoræ. This gelatinous substance contains the muscle-cells which enable the tentacles to contract. Surface of exumbrella smooth and devoid of cilia, excepting at aboral pole where we find a remarkable sense-organ consisting of a deep, ciliated, canal-like pit, the exterior opening of which is surrounded by a thick, pigmented ring of ectodermal cells bearing long, hair-like bristles. The deep-lying end of the pit contains two spherical lithocysts, each mounted on a slender stalk. These lithocysts are diametrically opposed. It is not clear from Dawydoff's description whether they are in the tentacular diameter or in a plane 90° from the latter, but judging from his figures, which we have copied, they lie in the same plane with the tentacles. The cilia of the canal of the sense-organ are vibratile in life. There are no excretory pores at the bell-apex near the sense-organ, such as are seen in Ctenophoræ.

Velum at the bell-margin similar in structure to velum of Hydromedusæ. Subumbrella cavity about half as deep as bell-height; the manubrium is a short, simple tube. The central stomach gives rise to an apical canal which ends blindly immediately under the apical sense-organ, and also to 2 lateral branches which lead to the bases of the 2 tentacles. There is no peripheral canal-system. The muscles of the subumbrella are poorly developed and the animal swims mainly by contractions of its powerful velum and by movements of its tentacles.

The tentacles are red and the bristle-bearing ring around the opening of the sensory canal at the bell-apex is orange. All other parts are colorless. No gonads were observed.

Three specimens were found by Dawydoff, swimming near the surface of the sea off Saparœa Island near Amboina, in July, 1902.

This Cœlenterate resembles the Hydromedusæ in the general shape of the bell and in the structure of the velum and manubrium. The presence of true nematocysts places it among the medusæ rather than among Ctenophoræ and the histology of the gelatinous substance of the bell resembles that of Hydromedusæ. On the other hand, it is the only known Hydromedusa which has an apical sense-organ *when adult*. It resembles the Ctenophoræ in having 2 diametrically opposite tentacles, which may be partially retracted into special sheaths. Moreover, the cores of these tentacles are not composed of entodermal cells, but of solid, gelatinous substance (mesoglœa) continuous with that of the bell-walls. The stomach gives rise to an axial and 2 lateral diverticula as in Ctenophoræ.

There are, however, no colloblasts, as in Ctenophoræ. Moreover, in Ctenophoræ we find an ectodermal pharynx, or stomodeum, and this is absent in *Hydroctena* as are also ciliated combs, so characteristic of Ctenophoræ. Indeed, were it not for its apical sense-organ which bears only a superficial resemblance to the apical sense-organ of Ctenophoræ, *Hydroctena* would be unquestionably classed among the Hydromedusæ. Its resemblances to the Ctenophoræ appear to me to be parallelisms and not due to genetic relationship to Ctenophoræ. I am inclined to regard *Hydroctena* as a highly specialized Narcomedusa. Maas believes *Hydroctena* to be a typical Narcomedusa, apparently *Solmundella*. Schneider on the other hand appears equally certain that it is a Ctenophore. "Where doctors disagree 'tis folly to be wise," and we must await the observation of future students.

Woltereck, 1905, finds that in the larval *Solmundella* and in the actinula larva of *Tubularia* there is an apical pole-plate, consisting of ciliated ectodermal cells. In *Tubularia* this pole-plate is surrounded by a ring-like ridge of ectoderm so that the ciliated cells become somewhat sunken beneath the general level of the apex. In view of these observations, the apical sense-organ of *Hydroctena* loses its extreme isolation and it becomes more than ever probable that *Hydroctena* is merely a highly-specialized Narcomedusa related to *Solmundella*.

Genus CUNOCTANTHA Haeckel, 1879, sens. emend.

Cunina (in part), Eschscholtz, 1829, Syst. der Acalephen, p. 116.—Lesson, 1843, Zooph. Acalèphes, p. 301.—Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 259.
Cunina, McCrady, 1857, Gymn. Charleston Harbor, p. 108.
Foveolia, Agassiz, A., 1865, North Amer. Acal., p. 51.
Cunina, Uljanin, 1876, Извѣстія Общества Любителей Естестознанія, etc., tome 24, Moskau.
Cunoctantha, Haeckel, 1879, Syst. der Medusen, p. 316.—Metschnikoff, 1881, Zeit. für wissen. Zool., Bd. 36, p. 437.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 361.—Metschnikoff, 1886, Arbeit. Zool. Inst. Wien, Bd. 5, p. 252.—H. V. Wilson, 1887, Studies Biol. Lab. Johns Hopkins Univ., vol. 4, p. 95.
Gastrodes (degenerate parasite), Korotneff, 1888, Zeit. für wissen. Zool., Bd. 48, p. 640.
Cunoctantha, Korotneff, 1891, Zeit. für wissen. Zool., Bd. 51, p. 618.—Maas, 1892, Zool. Jahrb., Abth. Anat., Bd. 5, p. 271, taf. 21, 22, 26 fign. (development of medusa-buds upon the larva).
Cunina, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 53.
Cunoctantha, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 66.—Woltereck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Jahresvers., p. 117.—Bigelow, H. B., 1909, Mem. Comp. Zool. at Harvard College, vol. 37, p. 51.

The type species is *Cunoctantha octonaria*, described by McCrady, 1857, from Charleston Harbor, South Carolina, under the name *Cunina octonaria*.

Haeckel established the genus *Cunoctantha* and describes *C. discoidalis* as the first species. This appears, however, to be a young stage of some *Cunina*, and McCrady's previously described *C. octonaria* should serve as the type of the genus.

Plate 55.

Fig. 1. *Cunoctantha octonaria*, mature male. Charleston Harbor, South Carolina, September 7, 1897. Lettering as in figure 2.

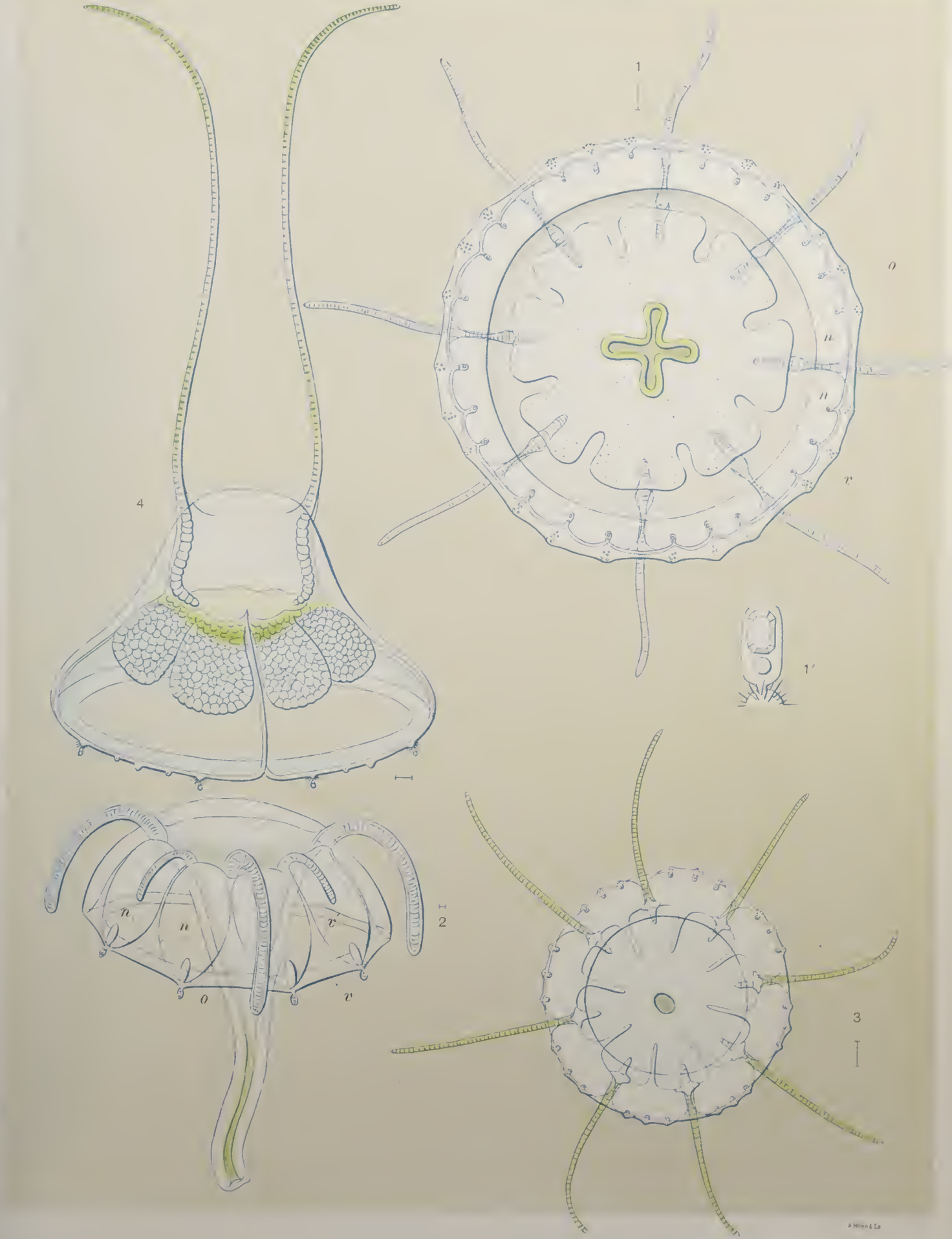
Fig. 1′. *Cunoctantha octonaria*. A sensory-club of the medusa shown in figure 1.

Fig. 2. *Cunoctantha octonaria*, young medusa removed from the manubrium of *Turritopsis nutricula* McCrady, to which it was clinging. In both figures 1 and 2, *n n* indicates the marginal nerve cord; *o*, otoporpa; *v*, annular part of the velum; *v′*, web-like part of the velum between the lappets. Charleston Harbor, South Carolina, September 10, 1897.

Fig. 3. *Æginura incisa*. Tortugas, Florida, June 30, 1899.

Fig. 4. *Solmundella mediterranea*, female. An oral view of this same medusa is shown in figure 1, plate 54. Tortugas, Florida, May 27, 1906

Drawn from life, by the author.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GENERIC CHARACTERS.

Æginidæ with 8 tentacles and 8 peronial furrows, alternating with 8 marginal lappets. With 8 peripheral, uncleft outpocketings of the central stomach in the radii of the 8 tentacles. A peripheral, peronial canal-system may or may not be present. Otoporpæ are found in all known forms of *Cunoctantha*.

We should not attempt to separate families of Narcomedusæ upon such a variable character as that of the presence or absence of the very degenerate peripheral canal-system. Also the presence or absence of "sensory" tracts above the marginal clubs is apparently no more important than the presence or absence of rows of nematocyst-cells over the exumbrella in many Anthomedusæ. It is safer to regard such slight differences as of specific, not of generic value. Moreover, the otoporpæ and peripheral canals may vary independently, and to consider both of them as of generic value would introduce a complexity into the classification which would cause closely related species to be widely separated, thus obscuring their actual relationship. It appears to me that the primary object of classification is to indicate genetic relationships, rather than to emphasize distinctions.

The larvæ of the medusæ of *Cunoctantha* are parasitic upon or within other medusæ. Thus *C. octonaria* infests *Turritopsis nutricula* and *C. parasitica* is parasitic upon or within *Geryonia*.

The development of these parasitic larvæ has been studied by McCrady, F. Müller, Haeckel, Uljanin, Metschnikoff, Brooks, Korotneff, Maas, Woltereck, and others, and will be treated of more in detail in the descriptions of the species. A remarkable case of degeneration is that of *Gastrodes parasiticum* A. Korotneff, 1888 (Zeit. für wissen. Zool., Bd. 48, p. 650, taf. 40, fign. 1–8). This is parasitic within the mantle cavity of *Salpa fusiformis*. It has neither muscles nor nettle-cells, but is a double-layered, thimble-shaped "larva," with a median supporting lamella, which forms a thick ring around the inverted margin. The œsophagus is turned inward like that of an anthozoan. The egg-cells develop in the ectoderm and the animal appears to become mature without developing into a medusa. It is inferred that this parasite is a degenerate *Cunoctantha* on account of its close resemblance to the larva of *Cunoctantha parasitica*, which develops in the gastric cavity of *Geryonia*, and finally produces free swimming medusæ by asexual budding.

One species, *Cunoctantha fowleri* Browne, produces medusa-buds asexually upon its stomach-pouches.

No sharp line of demarcation can be drawn between *Cunoctantha*, with its 8-rayed, free-swimming medusa stage, and *Cunina*, in which the free-swimming medusa has more than 8 rays. *Cunoctantha* is indeed retained only for purposes of classification, its genetic affinities being evidently very close to *Cunina*.

Cunoctantha octonaria Haeckel.

Plate 55, figs. 1, 1′, and 2.

Cunina octonaria, McCrady, 1857, Gymn. Charleston Harbor, p. 109, plate 12, figs. 4, 5; Proc. Elliott Soc. Nat. Hist. Charleston, S. C., vol. 1, plates 4–7.—Agassiz, L., 1862, Cont. Nat. Hist. U. S., vol. 4, p. 168.—Brooks, 1883, Studies Biol. Lab. Johns Hopkins Univ., vol. 2, p. 467; 1884, Zool. Anzeiger, Jahrg. 7, p. 710; 1886, Johns Hopkins Univ. Circular, No. 49, p. 86.—Maas, 1893, Ergeb. der Plankton Exped., Bd. 2, K. c., p. 53.—Agassiz, A., and Mayer, 1899, Bull. Mus. Comp. Zool. at Harvard College, vol. 32, p. 166.

Foveolia octonaria, Agassiz, A., 1865, North Amer. Acal., p. 51.

Cunoctantha octonaria, Haeckel, 1879, Syst. der Medusen, p. 316.—Brooks, 1886, Mem. Boston Soc. Nat. Hist., vol. 3, p. 361, plates 43, 44.—Wilson, H. V., 1887, Studies Biol. Lab. Johns Hopkins Univ., vol. 4, p. 95, plates 1–3, 19 figs.—Maas, 1892, Zoolog. Jahrb. Anat. Abth., Bd. 5, Heft 2, p. 274.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 52, plates 14, 15, and 17.

Mature medusa (plate 55, fig. 1).—Bell about 7 mm. in diameter, flatter than a hemisphere. 8 tapering tentacles, somewhat longer than bell-radius, project from sides of bell about midway between margin and apex; these tentacles are stiff and capable of but little movement and are carried bent downward in scimitar-like curves. The entodermal core of each tentacle consists of a row of disk-shaped, vacuolated cells. This core projects inward into the gelatinous substance of the exumbrella, immediately above the middle of the outer edge of

one of the 8 radial stomach-pouches. The root of each tentacle, where it fits into the gelatinous substance of the exumbrella, is thus covered with two layers of ectoderm, one being

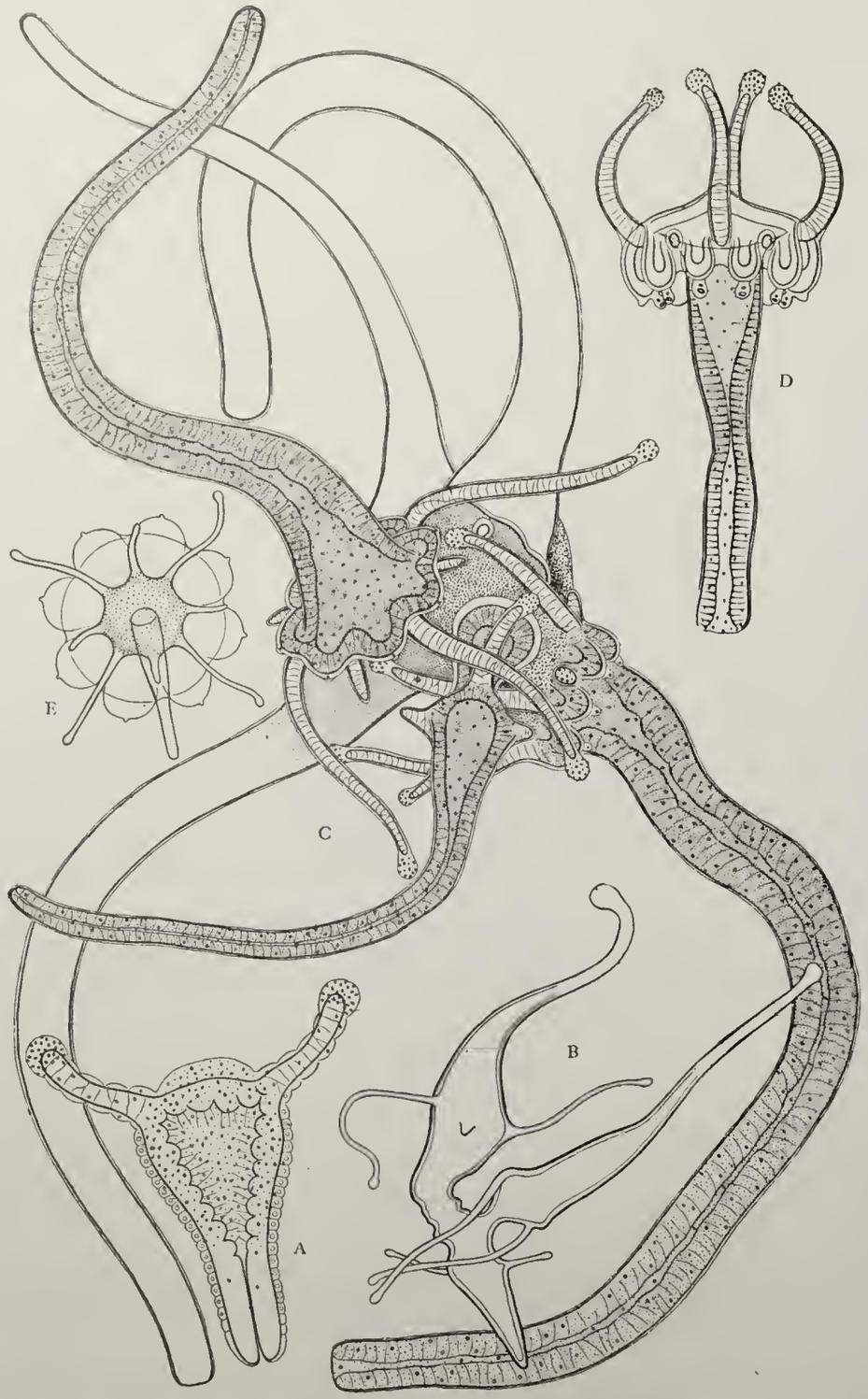


Fig. 304.—*Cunoctantha octonaria*, after Brooks, in Mem. Boston Soc. Nat. Hist., vol. 3. Showing development of actinula larva and young medusa.
A, young actinula. *B* and *C*, budding actinulæ giving rise to medusa-buds. *D*, young medusa with only 4 tentacles. *E*, aboral view of young medusa.

continuous with the general ectoderm covering the exumbrella and the other is continuous with the ectoderm of the main shaft of the tentacle. The ectoderm of the shaft of each tentacle

contains many nematocysts and also deep-lying muscle fibers. Just beneath and centrifugal to each tentacle-root is a thick pad of ectoderm-cells. This is the "peronium" of Haeckel and it probably serves to support the tentacle that arises immediately above it. 8 loops of the nerve-cord extend outward from the 8 peronia to the sense-organs upon the bell-margin. These 8 loops are put into connection one with another by means of nerve tracts that run through the peronia. Thus the nervous system consists of an 8-lobed, star-shaped ring of ciliated ectodermal cells situated upon the exumbrella (see plate 55, figs. 1 and 2, *n*, *n*).

In the adult medusa there are typically 24 marginal sense-organs, 3 in each octant of the bell, although occasionally there are as few as 2 or as many as 5 in an octant. Each sensory club is situated upon a small, hemispherical elevation of the bell-margin called the sensory cushion. The sensory cushion is formed from the cells of the nerve-cord, which at this place are elongate and spindle-shaped and bear long delicate bristles. Centripetal to the sensory cushion, on the exumbrella surface of the bell, there is a small, elliptical, elevated ridge, the otoporpa, composed of a single layer of cube-shaped ectoderm-cells and containing a number of nematocysts (see plate 55, figs. 1 and 2, *o*). The sensory-club is rod-like and cylindrical

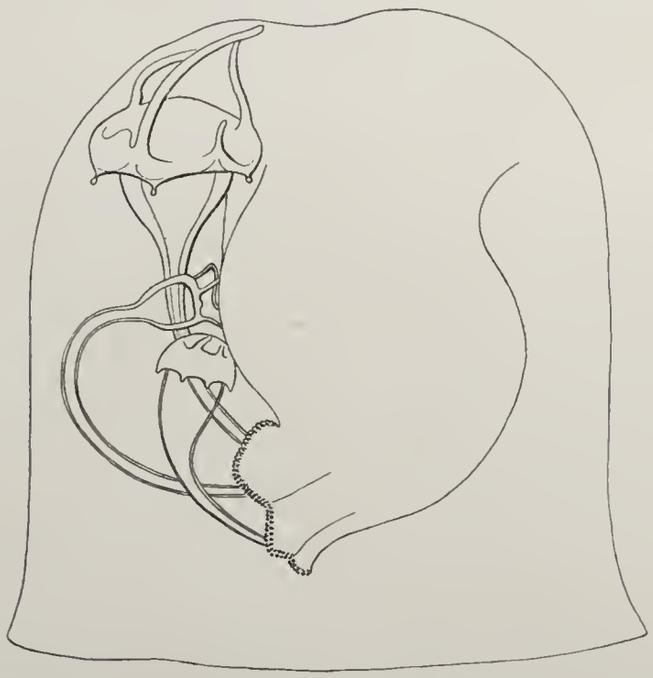


Fig. 305.—Larvæ of *Cunoctantha* attached to mouth of *Turritopsis nutricula*.
From drawing by Prof. W. K. Brooks.

and is attached to the sensory cushion by means of a short, narrow neck (see plate 55, fig. 1′). Each sensory-club contains two concretions that are situated within the entodermal core of the club. The proximal otolith is small and spherical, while the distal is large, flat, and crystalline.

The velum is more complex than in most hydromedusæ, for it consists not only of a simple annular membrane (see plate 55, figs. 1 and 2, *v*) that serves to partially close the opening of the bell-cavity; but in addition it extends upward as 8 Λ-shaped webs between the 8 loops of the nerve-cord (see plate 55, figs. 1 and 2 *v*′), and thus it is that, morphologically speaking, the margin of the exumbrella is bounded by the nerve-cord and hence the true form of the disk is to be considered as an 8-rayed star, although the thin webs of the velum stretched between the rays give it the appearance of a hemispherical bell.

Manubrium cone-shaped and there are 4 perradial, cruciform lips. 8 gastric sacs radiate outward from the central stomach-cavity, each sac being found in a tentacular radius. There are no radial-canals and no ring-canals in this species. The gonads are developed in the ectoderm of the subumbrella immediately beneath the 8 gastric sacs.

The medusa is colorless with the exception of a delicate sage-green tinge of the entoderm near the lips and occasionally in the tentacles.

The researches of McCrady, 1857, Brooks, 1886, and H. V. Wilson, 1887, have shown that during development the larva produces other larvæ like itself by budding. The life-history is as follows: The segmentation stages and early development of the ovum are unknown. The larva becomes an elongate, 2-layered, ciliated planula, in which condition it swims freely through the water and finally attaches itself by its mouth to the bell-margin of *Turritopsis nutricula* McCrady. The cilia then disappear and 2 tentacles develop at the aboral pole of the planula, and these are soon followed by 2 more tentacles situated 90° from the first pair. At about this time the larva enters the bell-cavity of its host and clings to the wall of the subumbrella by means of its tentacles, and while in this position it acquires a long cone-shaped throat-tube that enables it to insert its mouth into the mouth of the *Turritopsis*, and in this condition it leads a parasitic life. The larva is now in the "actinula" stage, for its appearance recalls the actinula larva of Tubularian hydroids but in Narcomedusæ the actinula may develop directly into a medusa and not into a hydroid-stock. In other species, however, it produces medusæ only by budding.

While the young *Cunoctantha octonaria* is in the actinula stage, other similar larvæ are often budded off from its aboral pole between the tentacles. These develop exactly as did the original larva and finally become free medusæ.

The umbrella first appears as 4 lobe-like outgrowths between the bases of the 4 tentacles. These lobes contain prolongations of the gastric cavity. The 4 tentacles retain their primitive position and thus come to lie in the notches between the lobes. The 4 primary lobes become 8 by the stoppage of growth of both ectoderm and entoderm at the middle point of the periphery of each lobe. As yet there are but 4 tentacles. 4 other tentacles soon appear, however, and then the umbrella consists of 8 lobes with a tentacle arising from each notch between the lobes. Later the velum grows between the lobes forming an interlobular web. The gelatinous substance of the exumbrella increases greatly in volume and grows over the bases of the tentacles, and thus the tentacle-roots become imbedded. When the young medusa is about 1.25 mm. in diameter, it leaves its host and leads a free existence (plate 55, fig. 2). At this time it has 8 tentacles and 8 marginal sense-clubs and is much like the adult in general appearance, except that the peripheral outline of the gastric cavity is a circle running through the intersection points of the 8 tentacles. At a much later stage an entodermal fusion takes place in the interradii and thus the 8 radial pouches of the stomach are formed.

Good accounts of the life-history of this medusa have been presented by McCrady, 1857, and by Brooks, 1886, and an excellent description of its finer structure has been given by H. V. Wilson, 1887.

The medusa is apparently found in all tropical oceans, for Maas describes it from the Malay Archipelago, and Bigelow from the Pacific coast of Mexico. It is common at Charleston, South Carolina, and Beaufort, North Carolina, where it infests the bell-cavities of *Turritopsis nutricula*. It has not been found either at Newport, Rhode Island, or at Tortugas, Florida, although *T. nutricula* is common at both of these places. It is a shallow-water species and is often seen in harbors.

Cunoctantha octonaria var. köllikeri.

Plate 54, figs. 4 to 9.

Cunina köllikeri, Müller, 1861, Archiv. für Naturgesch., Jahrg. 27, p. 42, taf. 4.
(?) *Cunoctantha octonaria*, Maas, 1905, Craspedoten Medusen der *Siboga* Exped., Monog. 10, p. 67, taf. 12, fign. 77, 78; taf. 13, fign. 83–85; 1906, Revue Suisse de Zool., tome 14, p. 98, plate 3, fig. 11.

Cunoctantha köllikeri Müller, 1861, from the coast of Brazil, bears a close resemblance to *C. octonaria*, and the same medusa has apparently been described by Maas, 1905, from the Malay Archipelago. Maas, however, describes a hood-like, or scale-like, expansion of exumbrella ectoderm over each marginal sense-club, and such expansions have not been seen in *C. octonaria*.

In both Müller's and Maas's medusæ the remarkable feature is the presence of numerous *Cunina larvæ* within the stomach-cavity of the medusa. There are often 60 to 80 of these larvæ developing within a single mother-medusa. In their early stages they consist of 7 to 12 outer cells which form a single layer inclosing 2 to 3 inner cells. These inner cells are all of

equal size and are somewhat larger than the cells of the outer layer, but there is no giant cell, such as Metschnikoff, 1881, and Woltereck, 1905, observed in the center of the larva of *Cunoctantha parasitica*.

All of the cells increase in number and a central cavity appears. Meanwhile the larva elongates. The tentacles appear one by one, starting with a single tentacle and ending with at least 12.

These *Cunina* larvæ are possibly parasites which enter the gastrovascular cavity of the *Cunoctantha* when young planulæ and there develop until the 12-tentacle stage. They are, however, not found in medusæ less than 3 mm. wide, but as they are said to appear in male as well as in female medusæ of *C. köllikeri*, it is improbable that they develop from eggs of the same species. Nevertheless it is possible that the statement that male medusæ develop these larvæ is mistaken and that we have here a three-generation cycle, such as has been studied by Stschelkanowzeff in *Cunina proboscidea*.

Cunoctantha actinulæ are often found in the Mediterranean attached to the subumbrella of *Aglaura* or *Rhopalonema*.

I believe that a "stolon larva" found floating in the Ocean at Tortugas, Florida, in July, 1904, is probably one of the generations of *Cunoctantha köllikeri*. It was producing numerous 8-rayed medusæ by asexual budding (see plate 54, figs. 4 to 9).

Cunoctantha polygonia Haeckel.

Cunoctantha polygonia, Haeckel, 1879, Syst. der Medusen, p. 317, taf. 19, fig. 3.

This medusa is described by Haeckel from the Mediterranean. It is about twice the size of *C. octonaria*, its bell being 16 mm. wide and 6 mm. high. The 8 marginal lappets are "hexagonal" and the 8 stomach-pouches "pentagonal." The 8 tentacles are shorter than in *C. octonaria*, being hardly as long as the marginal lappets. Also, there are 7 sensory-clubs on each of the 8 lappets, instead of 3 to 5 as is commonly the case in *C. octonaria*. The median sensory-club of each lappet is much larger than the others, whereas in *C. octonaria* they are of about a uniform size. The central stomach is wide and conical and is as long as the diameter between the tentacle-bases. There are 4 well-developed lips. The gonad forms a ring around the peripheral, ectodermal, subumbrella wall of the stomach and also extends out under the 8 pouches.

Haeckel figures a peronial, peripheral canal-system in this medusa, but it does not appear that he cut sections to determine this point.

Found by Haeckel at Corfu and Messina in 1877 and 1878.

Cunoctantha parasitica Metschnikoff.

Cunoctantha parasitica, Metschnikoff, E., 1881, Zeit. für wissen. Zool., Bd. 36, p. 437, taf. 28, fign. 7–16 (development of the larva); 1886, Arbeit. Zool. Inst. Wien, Bd. 6, pp. 252–253, taf. 23, fign. 27, 28.—Korotneff, 1891, Zeit. für wissen. Zool., Bd. 51, p. 618, taf. 31, fign. 15–19.
Cunina, sp., Maas, 1892, Jahrb. Zool., Abth. Anat., Bd. 5, p. 271, taf. 21, 22, fign. 1 to 26.
Cunina (*Cunoctantha*) *parasitica*, Woltereck, 1905, Verhandl. deutsch. Zool. Gesell., 15 Jahresvers., p. 117, fign. 12–14.
(?) *Cunoctantha* sp., Mayer, 1904, Mem. Museum Brooklyn Institute, vol. 1, p. 27, plate 4, fign. 36–42 (budding larva).
(?) *Cunina*, sp., Fewkes, 1884, American Naturalist, vol. 18, p. 302, fig. 7 (on Florida Reef, parasitic on *Geryonia*).

Mature medusa.—Bell 7 mm. wide, quite flat, walls not very thick, 8 tentacles alternating with 8 marginal lappets. The tentacles are somewhat longer than bell-radius. There are 5 marginal sense-organs on the margin of each of the 8 lappets. Each sense-club has one large or 2 small concretions. An elongate otoporpa is found above each sense-club. Mouth a round opening. Stomach flat, with 8 wide pouches in the radii of the tentacles. No peripheral canal-system. Stomach and pouches rose-red, tentacles decided green.

This species is parasitic, when young, in the gastric cavity of *Geryonia*. It is abundant in the Mediterranean, and its larva, or one exactly like it, was found at Tortugas, Florida.

The larvæ of *Cunoctantha parasitica* attach themselves to the bell-margin or lips of *Geryonia proboscidalis*, and then they enter the gastrovascular cavity of the *Geryonia*, apparently wandering in through the mouth, in order to undergo their further development in the stomach or peripheral canals of the *Geryonia*.

The development of these parasitic larvæ has been most carefully studied by Metschnikoff, Korotneff, Maas, and Woltereck; but although they were first observed within the gastrovas-

cular system of *Geryonia* more than fifty years ago, the life-history of the parasitic *Cunoctantha* is not yet completely known. The latest studies are those of Woltereck, 1905, who found numerous amœboid cells in the gallert of a young *Geryonia*. Some of these cells had one, others 2, 3, or more nuclei, and it is probable that the amœboid cells with 2 nuclei have resulted from the fusion of two mononuclear cells, but no such process has been actually observed in *C. parasitica*. In *Cunina proboscidea*, however, according to Metschnikoff, amœboid germ-cells wander out from both the male and female gonads, and after dividing for a time in the entodermal canals and gallert of the medusa they finally fuse in pairs, one cell engulfing the other of each pair. It seems possible, therefore, that a similar fusion takes place in the free germ-cells of *Cunoctantha parasitica*. However this may be, when the amœboid cells have 3 nuclei, it is seen that one is larger than the other two, and this difference becomes much greater when there are 4 and more nuclei.

The cell with the large nucleus grows rapidly and sends out pseudopodia into the gelatinous substance of the *Geryonia*. Meanwhile the small nuclei within this giant-cell have greatly increased in number and cell-walls arise between them so that the giant-cell contains within itself a cup-shaped cluster of small cells, each with a single nucleus.

This cup-shaped mass of cells then migrates to the surface of the still-enlarging giant nurse-cell and soon breaks through and forms a raspberry-like cap of cells upon one side of the giant-cell. The outer surface of the raspberry-shaped mass becomes ciliated. At first the cap is composed of a single layer of cells, but soon it becomes 2-layered and the outer layer becomes the ectoderm and the inner the entoderm of the larval *Cunoctantha*. 8 tentacles appear simultaneously around the sides of the cap-like larva. The 2-layered cap grows so as to inclose much of the giant nurse-cell, which still persists undivided and with only one nucleus, even after the larva begins to give rise to medusa-buds.

The later stages have been studied by Metschnikoff and Maas. The 2-layered larva elongates and gives rise to numerous medusa-buds upon its sides. Each medusa-bud is at first a simple evagination of both ectoderm and entoderm of the larva. The mouth breaks through before the lappets or tentacles develop. The 8 tentacles and 8 lappets develop simultaneously, both being outgrowths from the stomach-wall of the bud. The bell-margin has 8 lappets from the first and the tentacles do not change their position. The gelatinous substance is a product of the entoderm. There is no peripheral canal-system at any stage. The 8 radial stomach-pouches are formed through the flattening of the primitively polyp-shaped buds. It is evident that the medusæ arise as asexual buds, hence through an alternation of generations, from the stolon-like larva.

The young medusæ escape into the water, apparently, through the mouth of the *Geryonia*. When set free, the *Cunoctantha* has 8 marginal lappets alternating with 8 tentacles, which are about as long as the bell-radius. There are also 8 marginal sense-clubs, each with 2 small concretions. The otoporpæ above the sense-clubs develop after the clubs have appeared.

Cunoctantha fowleri Browne.

Cunoctantha fowleri, Browne, 1906, Trans. Linnean Soc. London, ser. 2, Zool., vol. 10, pp. 164, 177, plate 13, figs. 1, 2.

Bell 4 mm. wide, watch-glass-shaped, about 3 times as broad as high. 8 tapering tentacles, about equal in length to diameter of umbrella. The 8 marginal lobes have rounded outlines, with 5 sensory-clubs upon each of the lobes. There is a long, narrow line of nematocysts forming an otoporpa over the exumbrella above each sensory-club. Peronial furrows broad and shallow. Velum not present in the single specimen found. Mouth wide and circular when expanded, the central stomach flat and lenticular and less than half as wide as bell-diameter. The 8 radial stomach-pouches are quite narrow and the intertentacular spaces between them are wide. Each stomach-pouch is widest at its middle and is spindle-shaped in outline, being quite narrow where it arises from the stomach and also at its distal end. The pouches are not cleft at their distal ends by the insertions of the tentacles, for the roots of the tentacles lie above them as in other species of *Cunoctantha*.

The most remarkable characteristic of this medusa is the presence of medusa-buds in various stages of development upon the 8 peripheral stomach-pouches. These buds are not parasites, but are formed from both ectoderm and entoderm of the stomach-pouches and

project outward into the bell-cavity. The mouth-tube develops before the lappets and tentacles. The oldest bud had 8 tentacles, 8 lappets, and 16 sense-organs (2 on each marginal lappet).

The sperm or ova were not developed in the single specimen studied by Browne, and as he states the medusa is probably in an intermediate stage preceding sexual maturity, during which time it produces medusæ asexually.

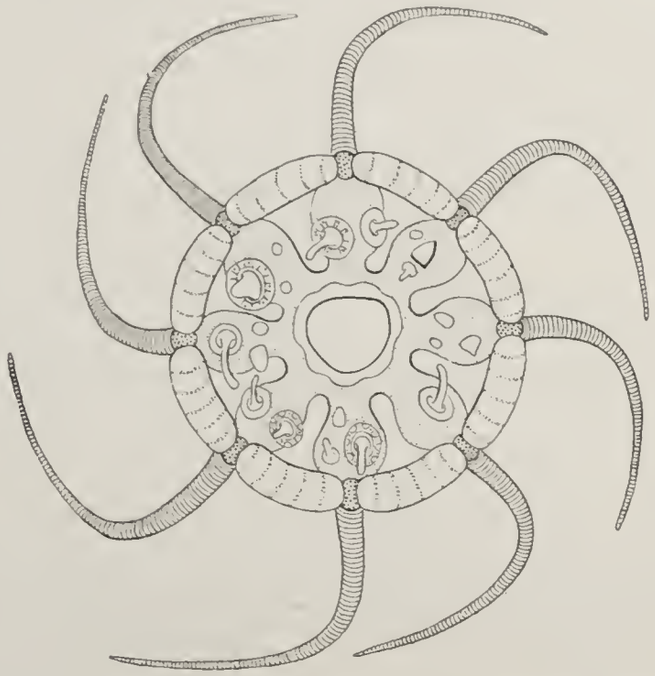


FIG. 306.—*Cunoctantha fowleri*, after Browne, in Trans. Linnean Soc. London.

Found in the Bay of Biscay between 50 fathoms and the surface.

It is the only *Cunoctantha* or *Cunina* known to produce medusa-buds as external outgrowths of its body-wall.

Cunoctantha tenella Bigelow.

Cunoctantha tenella, BIGELOW, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 54, plates 15–17.

Bell 7 mm. and more in diameter, higher than a hemisphere, exumbrella smooth. Lappet zone narrow but slightly incised in the tentacular radii. Peronial strands very short. 8 tapering tentacles, as long as bell-radius. At least 3 sense-clubs per lappet as in *C. octonaria* but the otoporpæ are less prominent. Stomach deep and lenticular with a round mouth-opening. 8 nearly triangular, pointed, gastric pouches. A well-developed peripheral, peronial canal-system is present, this being the only known form of *Cunoctantha* known with certainty to have marginal canals. Colorless. Gonads begin to develop when the medusa is 7 mm. wide. Common in Acapulco Harbor, Pacific coast of Mexico.

Genus ÆGINURA Haeckel, sens. emend.

Ægineta (in part), GEGENBAUR, 1856, Zeit. für wissen. Zool., Bd. 8, p. 261.

Cunoctona (larval form)+*Æginura*, HAECKEL, 1879, Syst. der Medusen, pp. 317, 343.

Æginura, HAECKEL, 1881, Report on Deep-sea Medusæ, *Challenger* Expedition, Zool., vol. 4, p. 41.—MAAS, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 37, Genre B, p. 34; 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, pp. 69, 76; 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 497.—BIGELOW, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 78.

Cunoctona+*Æginura*, VANHÖFFEN, 1907, Zool. Anzeiger, Bd. 32, pp. 175, 176; Narcomedusen der *Valdivia* Expedition, pp. 51, 71, 72.

The type species is *Æginura myosura* Haeckel, from the tropical Atlantic.

GENERIC CHARACTERS.

Æginidæ with 8 principal tentacles and 8 exumbrella furrows with 8 peronial strands in the radii of the tentacles and with 8 principal stomach-pouches in the radii of the 8 tentacles.

These 8 main pouches are, however, cleft by the 8 tentacles, thus giving 16 peripheral lobes, and they may be even further subdivided peripherally, so that there may be 32 peripheral outpocketings of the stomach; peronial loop-canals are usually present.

Haeckel's genus *Cunoctona* is separated from *Æginura* by the fact that there are otoporpæ above the marginal clubs in *Cunoctona*, whereas these are absent in *Æginura*. This distinction appears to me to be of specific rather than of generic value. *Æginura* as here defined is closely related to *Cunoctantha* but is distinguished by the fact that its 8 principal stomach-pouches are *cleft* by the roots of the 8 tentacles. In *Cunoctantha*, on the other hand, the insertions of the 8 tentacles lie above the 8 stomach-pouches, the outer margins of which are simple and *entire* and not cleft by the tentacles.

Vanhöffen, 1907, 1908, would restrict *Æginura* to include forms with a marginal canal-system, whereas *Cunoctona* according to his scheme would embrace medusæ having no peronial canal-system.

*Synopsis of Species of Æginura.**

	Æ. myosura Haeckel.	Æ. lanzerotæ = Cunoctona lanzerotæ Haeckel.	Æ. grimaldii Maas, 1904 = Æ. weberi Maas, 1905.
Shape and size of bell in mm.	Nearly hemispherical. 30 wide.	Flatter than a hemisphere. 15 wide, 5 high.	Hemispherical. 5 to 12 wide.
Length of 8 principal tentacles in terms of bell-radius (*r*).	4 radial tentacles = 2 *r*+. The 4 interradial tentacles = *r*. Radial tentacles arise from a zone higher up on sides of bell than the 4 interradial.	All 8 tentacles = *r*—	All 8 tentacles = 2 *r*.
Number and character of marginal sense-clubs.	16 marginal sense-clubs. Two in each of the 8 marginal lappets. No otoporpæ above clubs.	56 marginal sense-clubs. 7 on each of the 8 marginal lappets. With well-developed otoporpæ above clubs.	48 marginal sense-clubs. 6 on each of the 8 marginal lappets. No otoporpæ above clubs.
Number of secondary, or marginal, tentacles.	None.	None.	3 very small ones on margin of each of the 8 marginal lappels. Tentacles flanked by sensory-clubs.
Shape of mouth.	At end of neck which is half as long as bell-radius. Mouth cruciform, with 4 lips.	As in Æ. myosura, with 4 lips.	A simple, round opening.
Number of peripheral stomach-pouches and of loop-canals.	16 stomach-pouches, 8 loop-canals, well developed.	16 stomach-pouches, 8 loop-canals, narrow.	16 stomach-pouches, 8 loop-canals degenerate or absent.
Character of gonads.	In entoderm of subumbrella sides of the 16 peripheral stomach-pouches.	As in Æ. myosura.	In male, as in Æ. myosura. In female irregularly developed in small patches. Eggs few and large.
Color.	?	Central stomach, mouth-tube, and lips intense chrome-yellow. Tentacles and stomach-pouches rose-red. Margins of lappets orange-red.	Stomach and its pouches deep reddish-purple. Tentacles light-purple or colorless. Bell milky.
Where found.	Indian Ocean, south of Australia. Depth 2,150 (?) fathoms.	Tropical Atlantic. Near the surface.	At depths of 400 to 500 fathoms, Atlantic and Pacific.

**Æ. incisa* = *Cunoctantha incisa* Mayer is an immature form described in the text.

Æginura myosura Haeckel.

Æginura myosura, Haeckel, 1879, Syst. der Medusen, p. 343, taf. 19, fign. 8, 9; 1881, Report Deep-sea Medusæ, *Challenger* Expedition, vol. 4, Zool., p. 41, plates 13, 14, figs. 1–12.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 76.

Bell 30 mm. wide, 15 mm. high, flat top, evenly rounded, bulging sides probably almost hemispherical when alive. The 8 tentacles were not all of the same size. The 4 radial ten-

tacles are inserted higher up on the sides of bell and are longer than the 4 interradial tentacles. The 4 radial tentacles are slightly more than twice as long as the bell-radius, while the 4 interradial (undeveloped young?) tentacles are as long as the bell-radius. The 8 peronial strands are very wide immediately below the base of each tentacle, but become narrower as they approach the lower margin. There are 16 sensory-clubs, 2 upon each marginal lappet. They are elongate, widest at the outer end, and contain about 3 entodermal crystals. The club arises from a marginal sensory pad bearing long bristles, but there are neither sensory tracts nor "otoporpæ," on the exumbrella above the clubs. The central stomach is about two-thirds as wide as the disk itself. Peripherally it gives rise to 16 radiating pouches, the 8 adjacent to the 4 long tentacles being wider and almost twice as long as the 8 by the sides of the 4 small tentacles. This may indicate that the medusa is immature. The 8 peronial loop-canals are wide and conspicuous. The mouth is at the extremity of a cylindrical neck, which is half as long as the bell-radius. The lips are 4-lobed, the lobes being in the radii common to the 4 long tentacles. The gonads are developed in the ectoderm of the subumbrella under the 16 peripheral outpocketings of the central stomach.

The medusa exhibits indications of immaturity in the short length of its 4 interradial tentacles and in the small size of the 8 peripheral stomach-pouches on either side of them.

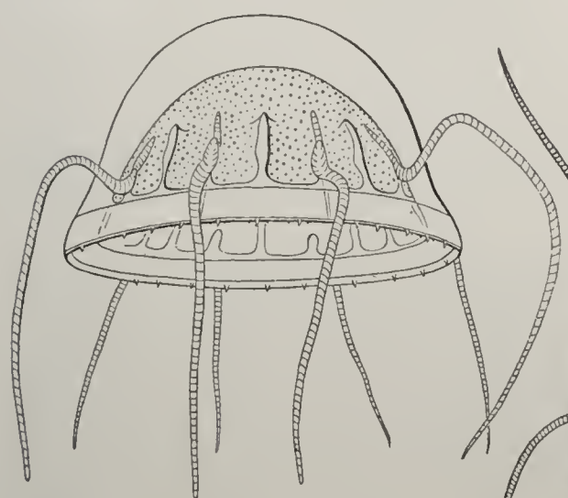
A single specimen, a male, was found by the *Challenger* at a depth of 2,150 (?) fathoms, south of Australia in the Indian Ocean, on March 10, 1874, lat. 47° 25′ S., long. 130° 32′ E.

Haeckel, 1881, gives a detailed description accompanied by beautiful figures.

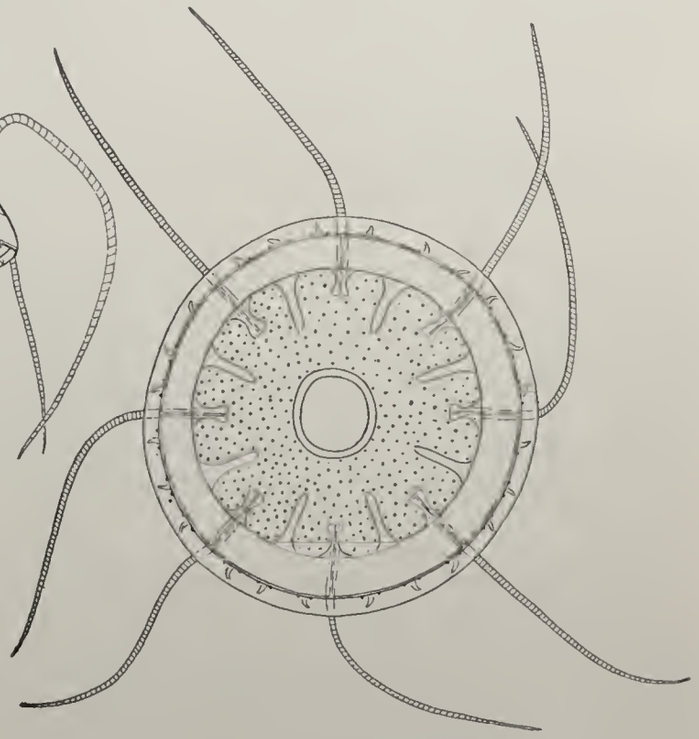
Æginura lanzerotæ Maas.

Cunoctona lanzerotæ+C. nausithoë, Hafckel, 1879, Syst. der Medusen, p. 318, taf. 20, fign. 1–6.
Æginura lanzerotæ, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 76.

Bell somewhat flatter than a hemisphere, 15 mm. wide, 5 mm. high. There are 8 semicircular marginal lappets about half as long as the tentacular radius. 8 stiff, tapering ten-



307.



308.

Figs. 307 and 308.—*Æginura "weberi"* after Maas, in Hydromedusen *Siboga* Expedition=*Æ. grimaldii.*

tacles, equal in length and somewhat shorter than the bell-radius, project from sides of bell about midway between margin and apex. There are 56 sensory-clubs, 7 upon each of the 8 marginal lappets. There are well-developed sensory tracts, or otoporpæ, above the sense-clubs, each tract being a spindle-shaped swelling upon the exumbrella and longer than the

sense-clubs themselves. Each club contains 3 to 4 crystalline concretions of entodermal origin, and the club itself is pyriform and mounted with its broad end upon a marginal sense-cushion which bears long bristles. Velum well developed and provided with circular muscles. The mouth is provided with 4 prominent lips and is cruciform and situated at the extremity of a 4-sided throat-tube so that the mouth is at about the level of the velar opening.

The central stomach is flat and octagonal and about half as wide as the medusa itself. It gives rise to 8 primary outpocketings in the radii of the 8 tentacles, 4 of these being in the radii of the cruciform lips and 4 alternating with them. These 8 principal pouches are deeply cleft in their middle by the 8 tentacles, so that there are 16 outermost stomach-pouches. These are rectangular with rounded angles and the clefts between adjacent lappets are very narrow, the pouches extending over the greater part of the area of the lappets. The 8 marginal loop-canals are well developed, each one arising from the central stomach on one side of a tentacle and extending around the margin of the lappet to reenter the stomach upon the adjacent side of the tentacle 45° away from its point of origin. The gonads are developed in the ectoderm of the subumbrella under the 8 principal stomach-pouches and their 16 terminal outpocketings. The eggs are very numerous and are uniformly distributed, not few in number and irregularly developed as in *Æginura grimaldii*.

The central stomach, mouth-tube, and lips are intense chrome-yellow. The entoderm of the peripheral pouches of the stomach and the tentacles is rose-red, and the margin of the lappets is orange-red.

This species was drawn from life by Haeckel in the Canary Islands, and later he had a larger preserved specimen from the Atlantic (?) coast of South Africa. Haeckel calls this larger specimen *Cunoctona nausithoë*, but it appears to be only a later stage of his Canary Island medusa. He gives attractive figures of *Æginura lanzerotæ*.

Æginura grimaldii Maas.

Æginura grimaldii, Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 38, planche 3, figs. 19–28.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 80, plate 9, fig. 4.

Æginura weberi, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 77, taf. 11, fig. 73; taf. 12, fig. 76; taf. 14, fign. 90–99.

Cunoctona grimaldi var. *munda*+ *C. guinensis*+ *C. obscura* Vanhöffen, 1909, Narcomedusen der *Valdivia* Expedition, p. 53, taf. 2 und 3.

Bigelow found four specimens of this medusa in the eastern tropical Pacific which ranged from 13 to 21 mm. in diameter, and Vanhöffen describes an apparently identical medusa as *Cunoctona obscura* from the coast of German East Africa which was 34 mm. wide.

The bell in specimens described by Maas from the Malay Archipelago is 3.5 to 5 mm. wide, and in an imperfect specimen from the North Atlantic 12 mm. wide. It is hemispherical with a slightly flaring margin. The gelatinous substance is thick at the apex, but thin at the margin. In the Malayan specimens the lower velar margin is entire and simple without notches, but in the North Atlantic specimen there were 8 slight notches in the positions of the 8 radial, peronial strands. The 8 peronial furrows are very shallow at the margin, especially in the Malayan specimen, but they become deeper the nearer they approach to the tentacles, and at the insertion of the tentacle each furrow forks and sends up a pair of blindly-ending, tapering branches which extend into the gelatinous substance on both sides of the base of each tentacle.

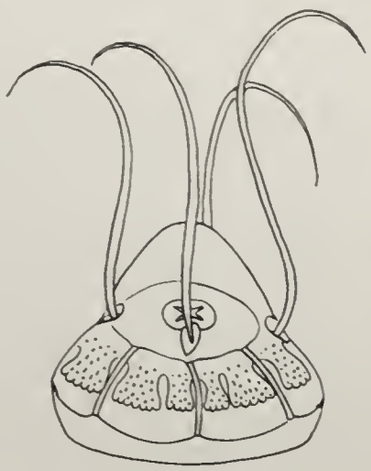
The 8 principal tentacles are stiff, tapering, and all of the same size and length. Their entoderm consists of a single row of chordate cells, set coin-like one after another in an axial row throughout the shaft of the tentacle, but at the base and root of the tentacle these cells are more confusedly grouped. These tentacles project out from the sides of the exumbrella, all at the same level, in a zone about one-third the distance from apex to margin above the lower margin. They bend in sickle-like curves downward toward the bell-margin and are about as long as the bell-diameter, or slightly longer. Besides the 8 long, principal tentacles there are 24 very small, tapering, secondary tentacles which arise from the margin; 3 in each inter-tentacular octant. The entoderm of these minute tentacles consists of chordate cells, similar in arrangement to the cells of the 8 principal tentacles. These secondary tentacles are only about one-twentieth as long as the bell-radius in the Malayan specimens, and even smaller in the North Atlantic specimens.

In the Malayan specimens there were 48 very minute sensory-clubs, a pair flanking each of the small marginal tentacles. These were not seen in the Atlantic specimen, but were probably lost through accident or destroyed by the manner of preservation. There are no sensory tracts, or otoporpæ, on the exumbrella above the sense-clubs.

The velum is well developed and provided with powerful ring-muscles. The mouth is a simple, round opening, and the central stomach is flat and lenticular and about two-thirds as wide as the bell-diameter. Peripherally the stomach gives rise to 8 principal, radial outpocketings, each of which is deeply cleft at its median outer edge at the place of insertion of the principal tentacles. There are thus 16 outermost pouches of the stomach. These peripheral pouches are rectangular with rounded corners and the pouches are not plane, but buckled in the gallert of the bell so that the 8 intertentacular clefts appear as if cut along the summit of a divided ridge between adjacent stomach-pouches.

There are 8 double, peronial canals in the Malayan specimens, which extend outward and downward from the lappets on both sides of the 8 principal tentacles and join to form the ring-canal in each interperonial octant. There are thus 8 marginal loop-canals, the loops alternating with the tentacles. These loop-canals are, however, very narrow and their entodermal lining is degenerate. No trace of peronial canals or ring-canal could be found in the Atlantic specimen and it is possible that they degenerate with growth and finally disappear.

309.



309*a*.

Fig. 309.—*Æginura grimaldii*, after Maas, in Résult. Camp. Sci. Prince de Monaco.
Fig. 309*a*.—*Æginopsis laurentii*, after Brandt, in Mém. Acad. St. Petérsbourg.

In the 3 male specimens from the Malay Archipelago, the gonads are developed over the ectodermal subumbrella walls of the gastric pouches, but in the female from the North Atlantic they are very irregularly developed in patches, in some places in the ectoderm of the pouches and in others at the bases of the pouches. The eggs are few in number but are of great size.

The gelatinous substance of the bell is milky-blue, translucent, not transparent. The entoderm of the stomach and pouches is deep reddish-purple and that of the tentacles light-purple or colorless.

Maas first describes a single large female specimen under the name *Æginura grimaldii*. This was collected by the Prince of Monaco at a depth of 390 fathoms in the North Atlantic in N. lat. 47° 42′ 41″, W. long. 17° 10′ from Greenwich. In the following year Maas described three smaller male specimens under the name *Æginura weberi*. These were found by the *Siboga* at a depth of 500 fathoms in the Malay Archipelago.

The resemblance between the Atlantic *grimaldii* and the Malayan "*weberi*" is so close that the slight differences may well be due to differences of sex and age, and I am inclined to unite the two species under the older name given by Maas (see text-figs. 307 and 308). *Æginura grimaldii* is probably a deep-sea medusa and, in common with many other deep cold-water forms, is of world-wide distribution.

The Atlantic specimen was damaged, whereas those from the Malay Archipelago were perfect, and on this account Maas presents a better description of the latter than of the former. He presents clear figures in both cases.

While the above description was in press Bigelow, 1909, published an excellent figure of one of 4 specimens of *Æ. grimaldi* which he describes from the eastern tropical Pacific. He agrees with my view that *Æ. grimaldi* is probably identical with *Æ. weberi*. His figures of the female show dense reddish-brown *Atolla* colored entoderm in the stomach and its pouches, and irregularly distributed, white eggs. The male gonads are, however, uniformly distributed over the ectoderm over-lying the gastric pouches. Bigelow shows 3 of the short, solid, tapering, marginal tentacles per interradial quadrant, such as Maas observed in his specimens.

Vanhöffen, 1908, has I believe described this medusa under three names as follows:

Where found.	Vanhöffen's name.	Color.	Diameter in mm.	Number of secondary tentacles per quadrant.	Number of sensory-clubs per quadrant.
Off the west coast of tropical Africa.	*Cunoctona grimaldi* var. *munda*.	Brown.	8 to 16	3	2
Off the west coast of tropical Africa.	*Cunoctona guinensis*.	Brown.	?	5	10
Coast of German East Africa.	*Cunoctona obscura*.	Very dark brown.	34	4	7

Vanhöffen's medusæ are of a deeper brown color, and most of them have more secondary tentacles and sensory-clubs than in the medusæ described by Maas and Bigelow; but the secondary tentacles of *Solmundella* are very variable in number, and one would expect the same to be the case in *Æginura*. Vanhöffen sectioned his specimens and demonstrated that there was neither marginal nor peronial canal-system.

Æginura incisa.

Plate 55, fig. 3.

Cunoctantha incisa, Mayer, 1900, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 66, plates 44, figs. 145, 146.

Immature medusa.—Bell 5 mm. wide, flatter than a hemisphere, with a low, wide, solid, apical projection. 8 tentacles, each 1.5 times as long as the bell-radius. 24 sensory-clubs, 3 in each intertentacular octant, each with a single crystalline concretion, and with 24 otoporpæ above the clubs, 8 open peronial furrows. Velum wide. Mouth a simple, round opening. Central stomach gives rise to 8 main radial pouches in the radii of the 8 tentacles and the outer ends of these pouches are cleft by the conical roots of the tentacles so that there are 16 short outermost stomach-pouches. Peripheral canal-system (?) Gonads not developed.

Entoderm of the tentacles and stomach is delicate green, other parts colorless. Two specimens found at Tortugas, Florida, on the surface, in May, 1899.

This is apparently an immature *Æginura*, but I can not state that it is the young of any described form.

Genus ÆGINOPSIS Brandt, 1835.

Æginopsis, Brandt, 1835, Recueil Actes séances publiques Acad. Imp. Sci. St. Pétersbourg (separate), p. 22; 1838, Mém. Acad. Imp. St. Pétersbourg, Sci. Math. et Nat., sér. 6, tome 4, par. 2, p. 363.—Haeckel, 1879, Syst. der Medusen, p. 342.—Maas, 1906, Fauna Arctica, Jena, Bd. 4, Lfg. 3, pp. 485, 497.—Vanhöffen, 1907, Zool. Anzeiger, Bd. 32, p. 176.

The type species is *Æginopsis laurentii* Brandt, from the Arctic Ocean.

GENERIC CHARACTERS.

Æginidæ with 8 peronial strands, 4 tentacles, and 16 (8 cleft) peripheral stomach-pouches.

Æginopsis laurentii Brandt.

Æginopsis laurentii, Brandt, 1838, Mém. Acad. St. Pétersbourg, sér. 6, tome 4, Sci. Nat., p. 363, taf. 6, fig. 1–6.—Agassiz, A., 1865, North Amer. Acalephæ, p. 54.—Birula, 1896, Annuaire Musée Zool. Acad. Imp. Sci. St. Pétersbourg, tome 1, p. 347.—Vanhöffen, 1898, von Drygalski, Grönland Expedition, Bd. 2, p. 273.—Linko, 1905, Zool. Anzeiger, Bd. 28, p. 219.—Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, pp. 485, 510, Jena (review of literature).

Æginopsis laurentii + *Æ. mertensii*, Hafckel, 1879, Syst. der Medusen, pp. 242, 243.

Solmundus, sp., Fewkes, 1888, Lady Franklin Bay Expedition, Appendix xi, vol. 2.

(?) *Solmundus glacialis*, Grönberg, 1898, Zool. Jahrb., Abth. Syst., Bd. 11, p. 466, taf. 27, fign. 7, 8.

Solmaris tetranema, Hargitt, 1902, Biol. Bulletin Woods Hole, vol. 4, p. 17, fig. 5; 1904, Bull. U. S. Bureau of Fisheries, vol. 24, p. 58, fig.

(?) *Solmundus glacialis*, Broch, 1907, Report 2d Arctic Exped. in the Fram, Hydroiden und Medusen, p. 8.

Bell hemispherical or higher, 15 to 25 mm. wide. 8 peronial strands 45° apart, 4 tentacles 90° apart, project from the sides of the bell in the radii of 4 alternate, peronial strands. These tentacles are 1 to 2 times as long as the bell-diameter. There are 16 terminal, peripheral stomach-pouches on which gonads are developed. There is apparently no ring-canal (?) The mouth is a simple, round opening at the center of the lenticular stomach. The bell-margin displays 4 deep clefts in the radii of the tentacles and 4 shallow clefts 90° apart from these. The medusa is translucent bluish or faint red. Sensory-clubs (?) (See fig. 309*a*.)

This species appears to be fairly common in the Arctic Ocean. It ranges from Japan northward in the Pacific, and from the southern coast of New England northward in the Atlantic.

It is a difficult medusa to preserve and our knowledge of it is still very imperfect. In common with many other Narcomedusæ the extreme transparency of the bell renders it difficult to distinguish the shape of the stomach-pouches in living specimens.

Æginopsis (?) pachyderma.

Campanella pachyderma, Agassiz, A., 1865, North Amer. Acal., p. 52, figs. 70–75.—Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog, 10, p. 70.
Ægina (*Æginaria*) *pachyderma*, Haeckel, 1879, Syst. der Medusen, pp. 339, 340.
Ægina pachyderma, Maas, 1905, Craspedoten Medusen der *Siboga* Expedition, Monog. 10, p. 70.

The bell is about 1.5 mm. in diameter and is flatter than a hemisphere, the sides being somewhat flaring. There are 4 radially situated, stiff tentacles, each being about 1.5 times as long as the bell-diameter. These tentacles are covered with clusters of nematocyst-cells. Each tentacle is said to be provided with a large basal bulb, the upper side of the ectoderm of which contains a number of brown-colored pigment-granules, while in the lower portion there is a dark-brown pigment-spot. The tentacles are said to be hollow and their bases are put into communication each with each by means of the circular vessel (?) There are said to be 8 simple "radial tubes." 4 of these lead to the 4 tentacles and the 4 others are situated 45° away from the latter. The velum is very large and hangs downward below the level of the tentacles. It consists of 8 loops corresponding to the 8 "radial tubes." The manubrium is conical and is about as long as the bell-height. It is capable of much contraction and expansion. The mouth is a simple, round opening. The gonads occupy 8 horseshoe-shaped pouches of the gastrovascular cavity situated midway between the 8 "radial tubes." The bell is of an ocher-yellow color and there are a number of dark-brown nematocyst-bearing spots scattered over its outer surface. Marginal sense-clubs (?)

The above description, taken from that of A. Agassiz, 1865, has been supplemented by a study of his original figures. It is reproduced in the hope that the medusa may in the future be recognized. In his assiduous studies of the medusæ of the New England coast, Dr. Agassiz discovered a number of species which have not been taken since. Moreover, in the days when he made the studies for his "North American Acalephæ" the water was pure in many harbors now polluted and the medusa-fauna has greatly changed in consequence. Therefore, although this extraordinary medusa has not been seen since its discovery in 1862 at Nahant, Massachusetts, in July and September, we can not discard it merely because recent explorations have failed to reveal it.

If Dr. Agassiz's account be accurate, this medusa exhibits certain extraordinary features the combination of which is not seen in any known Narcomedusa. For example, it is stated to have prominent *clusters of nematocysts* upon its *hollow* tentacles, and to have basal *ocelli*. The 8 "radial tubes" may be peronial strands (?) This being the case, the medusa might be a young *Æginopsis*, but it is possible that the 4 interradial "canals" are merely appearances due to contraction and the medusa may be a young *Ægina*.

Genus CUNINA Eschscholtz, 1829.

Cunina, Eschscholtz, 1829, Syst. der Acalephen, p. 116.—Schulze, 1875, Mitt. Naturw. Verein Steiermark, p. 125 (development).—Metschnikoff, 1886, Embryol. Studien an Medusen, Wien, pp. 23, 102 (development).—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 51; 1904, Résultats Camp. Sci. Albert 1er Prince de Monaco, fasc. 28, p. 31.—Woltereck, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Jahresvers., p. 117 (development).—Stschelkanowzeff, 1906, Mitth. Zool. Sta. Neapel, Bd. 17, p. 433.—Bigelow, H. B., 1909, Mem. Mus. Zool. at Harvard College, vol. 37, p. 55.
Cunina, Haeckel, 1879, Syst. der Medusen, pp. 318.

GENERIC CHARACTERS.

Æginidæ with 9 or more tentacles which arise from the outer ends of an equal number of simple, uncleft, peripheral stomach-pouches. With otoporpæ above the marginal sense-clubs.

Cunina is so closely allied to *Solmissus* that I have felt inclined to merge the two under the older name *Cunina*, but Dr. Henry B. Bigelow, who has studied these forms in the extensive collections made upon Dr. Alexander Agassiz's recent expedition to the tropical Pacific, kindly advises me of the desirability of separating the genera. He states that *Solmissus lacks* exumbella sensory tracts above the sense-clubs, whereas these are invariably found in *Cunina*. Moreover *Solmissus* lacks a marginal ring-canal system, while the species of *Cunina* may or may not exhibit this character.

Synopsis of the Described Forms of Cunina.

	C. campanulata Eschscholtz, 1829, Syst. der Acal., p. 116, taf. 9, fig. 2.	C. globosa Eschscholtz, 1829, Syst. der Acal., p. 117, taf. 9, fig. 3.	C. lativentris Gegenbaur, 1856, Zeit. fur wissen. Zool., Bd. 8, p. 260, taf. 10, fig. 2.	C. proboscidea E. and L. Metschnikoff.	C. prolifera, Gegenbaur.
Shape and size of bell in mm.	Globular, fuller than a hemisphere. 40 wide, 30 high.	Globular, rather high, somewhat conical. 15 wide.	Flat, conically rounded. 12 to 20 wide, 6 to 8 high.	Pear-shaped. 42 to 57 wide.	Nearly hemispherical. 16.5 wide, 8 high.
Number of tentacles, lappets, and stomach-pouches.	10	10 10 14	10 to 12	9 to 14	7 to 16
Shape of stomach-pouches.	Widening outwardly, with outer margins nearly touching.	Wide, quadratic, with rounded angles. More than twice as wide as septa between them.	Long, narrow. Near outer ends twice as wide as near bases.	Rectangular. Much wider than interradial clefts between them.	Short, wide, and rounded outwardly. Mere notches in stomach margins.
Shape of marginal lappets; length in terms of diameter of central disk.	Blunt, quadratic. Length one-fourth.	Quadratic. Length one-third.	Rounded outwardly. Length one-fifth —.	Bluntly rounded.	Length two-thirds. Rectangular, with rounded margins.
Shape of central stomach and mouth.	Lenticular. Mouth a round opening.	Lenticular. Mouth a round opening.	Lenticular with conical throat-tube.	Conical, mouth projects beyond velar opening.	Flat, lenticular. Mouth a round opening.
Length of tentacles in terms of bell-radius (r).	0.5 r+	0.5 r+	0.5 r+	0.2	Two-thirds r to r.
Number of sensory-clubs on each lappet margin.	?	3	4	3 to 4	4 to 8
Color.	Colorless.	Stomach opaque, faint blue.	Gonads white to light-yellowish. Other parts colorless.	Stomach and tentacles milky. Other parts colorless.	Tentacles red, darker at tips.
Where found.	Atlantic Ocean, north of the Azores.	Equatorial region of Pacific Ocean.	Mediterranean in spring. Atlantic throughout the year.	Abundant in the Mediterranean.	Common in Mediterranean.
Remarks.	Eschscholtz's description and figures are too vague to enable one to determine this species with certainty.	Well described by Bigelow.	This may be identical with C. campanulata.	Distinguished by pyriform bell, very short tentacles and conical stomach.	A medusa-generation, having 4 to 11 or more tentacles, develops in stomach of mother-medusa. This species is distinguished by its red tentacles, rounded, dome-like bell, and flat, lenticular stomach.

*Synopsis of the Described Forms of Cunina.**—Continued.

	C. multifidia Haeckel, 1879, Syst. der Medusen, p. 322.	C. duplicata Maas.	C. oligotis Haeckel, 1879, Syst der Medusen, p. 319.	C. mucilaginosa de Blainville=Medusa mucilaginosa Chamisso and Eysenhardt.
Shape and size of bell in mm.	Flat, 30 wide, 8 high.	Flat, conically rounded. 20 wide.	Nearly spherical. 10 wide, 10 high.	Hemispherical. 60 to 70 wide, 30 high.
Number of tentacles, lappets, and stomach-pouches.	32	16. 8 long and 8 short.	16	20 to 24
Shape of stomach-pouches.	Narrow, elongate, widening outwardly and separated by wide intervals. One-fourth as long as diameter of central lens.	About as wide as spaces between them. Pouches with straight sides and rounded outer margins. Those in the radii of the 8 long tentacles are larger and longer than the others.	Narrow, long, separated by septæ of width equal to that of pouches themselves.	Quadratic, about one-sixth as long as bell-diameter.
Shape of marginal lappets; length in terms of diameter of central disk.	Small, egg-shaped. Length one-sixth.	Rectangular, with rounded outer angles. 1.5 times as long as wide.	Oval. Length one-fourth.	?
Shape of central stomach and mouth.	Mouth simple.	Lenticular, with round mouth opening.	Mouth simple.	?
Length of tentacles in terms of bell-radius (*r*).	One-sixth *r*.	Short. Exact size?	2 *r*	One-sixth *r*.
Number of sensory-clubs on each lappet margin.	2 to 3	3 with otoporpæ.	1	9
Color.	?	?	?	Colorless.
Where found.	Indian Ocean.	Near Cape Verde Islands. Depth of 500 fathoms.	Atlantic coast of South Africa.	Tropical Pacific, Atlantic, and Indian Oceans.
Remarks.	May this not be identical with C. mucilaginosa (?)			

* For *Cunina peregrina* see text.

In *Cunina* the stomach-pouches are in some species mere radiating tubes from the outer extremities of which the tentacles arise, while in others they are very wide. The gonads develop either in the ectoderm of the stomach-wall, in the stomach-pouches, or in both places. The marginal lappets alternate with, and are equal in number to, the tentacles. Sensory-clubs containing crystalline concretions of entodermal origin are found upon the free outer margins of the lappets along the line of the exumbrella nerve-ring. The clubs themselves are placed upon pad-like elevations composed of bristle-bearing, ectodermal cells. Sensory tracts of ectodermal cells may or may not extend upward from the bell-margin above these sensory-clubs. A peripheral canal-system has been demonstrated in some species of *Cunina*, but is absent in others.

Cunina is closely related to *Cunoctantha*, but in *Cunoctantha* there are 8 and in *Cunina* 9 or more tentacles and lappets. The larvæ of *Cunina* are parasitic within or upon Geryonidæ and other Cuninas as are those of *Cunoctantha*; but the development of the majority of the species remains imperfectly known.

Stschelkanowzeff, 1906, states that in *Cunina proboscidea* there are three generations, as follows: First, the large, free-swimming medusa with 9 to 14 tentacles, the eggs of which migrate into its own stomach and there develop into 4-tentacled, degenerate medusæ (generation 2d). The eggs of the latter are set free in the ocean and develop into planula larvæ (generation 3d) which attach themselves to *Geryonia* or other medusæ and grow into a stolon which gives rise to medusæ of generation (1) by asexual budding.

Metschnikoff, 1886, gives a different account of this process, and the details of the controversy are discussed under *Cunina proboscidea*.

A remarkable *Cunina larva* (?) has been described by Korotneff from the mantle jelly of *Salpa fusiformis* as *Gastrodes parasiticum* (see *Cunoctantha*).

The species of *Cunina* are widely distributed throughout all tropical seas, but are especially abundant in the Mediterranean, being rare elsewhere. None are known from polar regions.

C. campanulata Eschscholtz, of the Atlantic, is probably identical with *C. lativentris* Gegenbaur, of the Mediterranean, but Eschscholtz's description and figure are so vague that we will probably never be able to determine the identity of the oldest species of the genus. Similarly *C. globosa* Eschscholtz, of the tropical Pacific, is possibly identical with "*Ægineta globosa*" Gegenbaur, from the Mediterranean.

The following table will serve to indicate the distinctions between the described forms of *Cunina*. I believe that more careful studies will greatly reduce these so-called "species."

Cunina globosa Eschscholtz.

Cunina globosa, Eschscholtz, 1829, Syst. der Acalephen, p. 117, taf. 9, fign. 3*a-c*.—Haeckel, 1879, Syst. der Medusen, p. 319.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 57, plates 15 and 17.
(?) *Ægineta globosa*, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 263, taf. 10, fig. 8.

See synoptic table of species of *Cunina* and text-figures 311-312.

Eschscholtz, 1829, described this form from a specimen found near the Gilbert Islands, tropical Pacific. *Ægineta globosa* Gegenbaur, of the Mediterranean, is possibly identical with the Pacific form. Bigelow gives a good description of the Pacific medusa.

Cunina lativentris Gegenbaur.

Cunina lativentris, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 260, taf. 10, fig. 2.—Hertwig, O. und R., 1879, Nervensyst. Sinnesorgane Medusen, pp. 15, 30, etc., taf. 1, fign. 1-6; taf. 10, fig. 4 (histology).—Haeckel, 1879, Syst. der Medusen, p. 320.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 31.
(?) *Cunia campanulata*, Eschscholtz, 1829, Syst. der Acalephen, p. 116, taf. 9, fign. 2*a-b*.

See synoptic table of species of *Cunina* and text-figure 315.

The brothers Hertwig have made a special study of the histology of the sensory-clubs in this species. These clubs arise by a narrow pedicel from the exumbrella side of the velum, along the course of the upper nerve-ring. The club is placed upon a bristle-bearing pad of thickened ectoderm and a tract of this same ectoderm extends upward above the club over the exumbrella. The core of the club is entodermal and is connected with the entoderm of the supporting lamella by a narrow strand. The 2 concretions are secreted by the entoderm of the club. The club projects freely into the water and is not inclosed by the walls of the cushion-like "auditory" pad as in *Trachynema*.

C. lativentris is very abundant in the Mediterranean only in the spring months, but is found throughout the year in the Atlantic. It is probably identical with *C. campanulata* of Eschscholtz, 1829; the latter is, however, so vaguely described that it had best be considered as an obsolete species.

Cunina proboscidea Metschnikoff.

Cunina proboscidea, Metschnikoff, E. und L., 1871, Nachr. kaiserlich, Gesell. Freunde Naturwissen. Moskau, tome 8, p. 66, taf. 6, fign. 1-3.—Haeckel, 1879, Syst. der Medusen, p. 652.—Metschnikoff, E., 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 249, taf. 23, fign. 24-26; 1886, Embryol. Studien an Medusen, Wien, pp. 23 (egg), 102 (sporogony and budding), taf. 11, fign. 1-38; taf. 12, fign. 1-21.—Chun, 1894, Brown's Thier-Reichs, Bd. 2, Abth. 2, p. 239 (development).—Wolterecк, 1905, Verhandl. Deutsch. Zool. Gesell., 15 Jahresvers., p. 117 (development).—Stschelkanowzeff, 1906, Mitth. Zool. Sta. Neapel, Bd. 17, p. 433, taf. 29, 30, fign. 1-43; 1906, Zoolog. Centralblatt, Bd. 13, p. 675.
(?) *Cunina dodecimlobata*, Kölliker, 1853, Zeit. für wissen. Zool., Bd. 4, p. 321.
Cunina vitrea (young medusa), Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 259, taf. 10, fig. 1.

This common Mediterranean *Cunina* is distinguished by its long, conical throat-tube which projects beyond the velar opening, and by its very short tentacles. The bell is conical to pyriform, 42 to 57 mm. wide. There are 9 to 14 tentacles only 4 to 5 mm. long. The long, rectangular stomach-pouches are much wider than the interradial clefts between them. I find that sections stained in Delafield's hæmatoxylin show that the peronial canals and marginal system is degenerate and mainly sealed over. Short lengths of the peronial canals are sometimes found but they are merely disconnected lacunæ and end blindly. Each sense-club has 3 concretions and there is an otoporpa over the exumbrella above it. The otoporpa is short, club-shaped, and widest above. Each lappet bears 3 to 4 sensory-clubs. A conical mass of gelatinous substance projects downward into the stomach cavity. The females outnumber the males. Metschnikoff (text-figure 316) gives a good figure of this medusa.

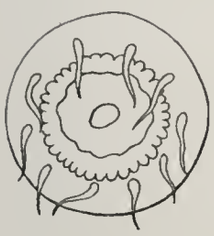
My studies at Naples lead me to believe that *Cunina vitrea* Gegenbaur is only the young of *C. proboscidea*. It is distinguished only by its smaller size, narrower stomach-pouches, and flatter, less conical stomach, but all of these change in larger medusæ so as to approach the conditions typical of *C. proboscidea*.

311.

312.

315.

313.



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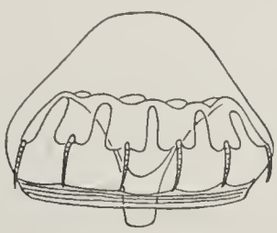

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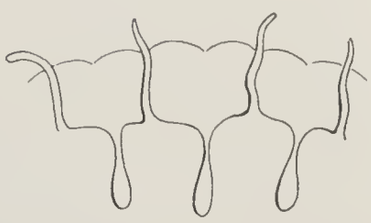
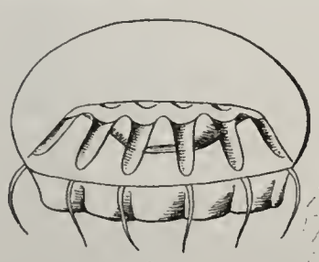


314.

FIGS. 311 AND 312.—*Cunina globosa*, after Eschscholtz.
FIGS. 313 AND 314.—*Cunina campanulata*, after Eschscholtz.
FIG. 315.—*Cunina lativentris*, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.
FIG. 316.—*Cunina proboscidea*. After Metschnikoff, in Arbeit. Zool. Inst. Wien.

Metschnikoff, 1886, and Woltereck, 1905, find that amœboid, "neutral" germ-cells wander out from both the male and female gonads of *Cunina proboscidea*. These amœboid cells then begin to divide in the entodermal pouches and gelatinous substance of the subumbrella. After this process of division these cells fuse with one another, so that one of the



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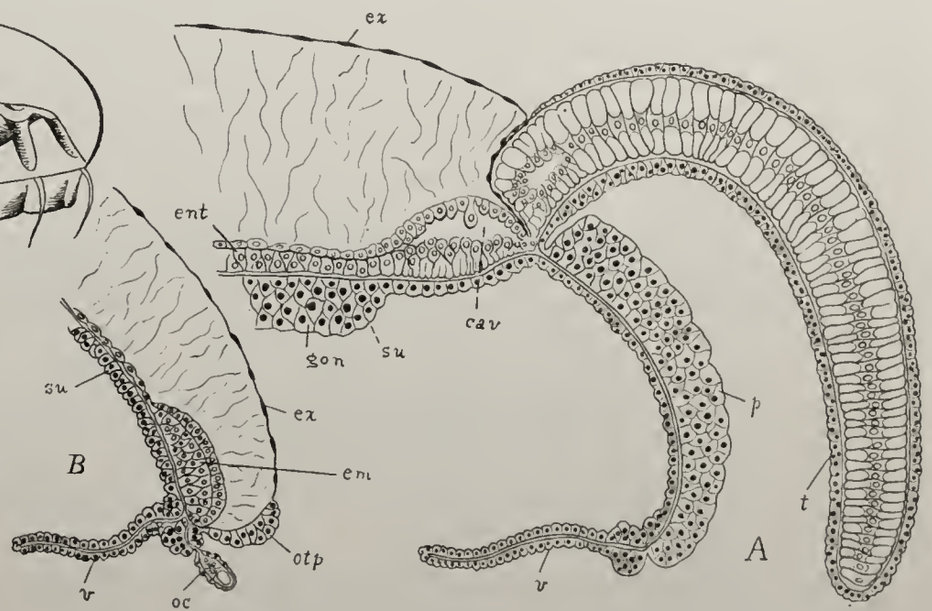

317.

FIG. 317.—*Cunina proboscidea*. Drawn by the author, from sections of a medusa collected at Naples by Dr. Lobianco. *A*. Radial section through a tentacle and its peronium. *B*. Radial section through a sense-club and its otoporpa. In both figures ectodermal nuclei are shown as black dots while entodermal are circles. *Cav*, indicates the outer extremity of the perradial stomach-pouch. *em*, the solid cord of entoderm at the bell-margin in the place of the ring-canal which is here absent. *ent*, entoderm. *ex*, exumbrella. *gon*, gonad. *oc*, sensory-club. *otp*, otoporpa. *p*, peronium. *su*, subumbrella. *t*, tentacle. *v*, velum.
FIG. 318.—*Cunina "vitrea,"* after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8=*C. proboscidea?*

component cells incloses the other. The inclosed cell then divides and develops into an embryo, while the enveloping cell becomes very large, sends out pseudopodia-like processes, and serves apparently only for the attachment, locomotion, and nutrition of the embryo. The embryo grows and hangs freely in the gastric cavity of the *Cunina proboscidea*, while the enveloping giant-cell attaches it to the entodermal wall. The embryo then becomes free in the gastric cavity of the *Cunina* and develops into a medusa which produces medusa-buds from its aboral pole. These budded medusæ are sexually mature when they emerge into the ocean and have only 4 tentacles, no marginal lappets, 20 sensory-clubs, no otoporpæ, no stomach-pouches, and a ring-like gonad in the ectoderm of the subumbrella. They thus resemble a *Solmaris* rather than a *Cunina*.

Metschnikoff calls this extraordinary developmental process "sporogeny."

Stschelkanowzeff, 1905, 1906, however, in a carefully studied research, has given an explanation of this remarkable development of medusæ within the stomach-cavity of *C. proboscidea* which is probably more nearly correct, and which would dispense with Metschnikoff's hypothesis of "sporogeny."

According to Stschelkanowzeff both the male and female sexual products originate in the ectoderm of the stomach-wall of the free-swimming medusa of *C. proboscidea*. The eggs, however, migrate through the supporting lamella into the entoderm of the stomach-wall of the medusa and are there fertilized by the small oval spermatozoa. There are 30 chromosomes. The segmentation is total and practically equal and a solid morula develops. This morula comes to lie in the gastrovascular cavity of the medusa, but retains an attachment with the entodermal wall, which forms an open fold or follicle around it. The entoderm of the larva is formed by delamination, the innermost cells of the morula becoming entodermal. Thus we have a small, sac-shaped larva with its thick, outer ectodermal wall composed of several layers of cells and a single layer of smaller cells constituting its degenerate entoderm. Then 2 tentacles grow out from the aboral surface of the larva, and soon 2 others, 90° apart from the original pair, appear, giving in all 4 tentacles. The rudimentary bell and velum then grow out from the sides of the body of the larva, about 15 sensory-clubs appear at intervals around the margin, and a rudimentary marginal nervous system develops. Practically no gelatinous substance is found and the velum, tentacles, and bell collar are very small and rudimentary. The mouth breaks through on the upper side of the larva and sexual products (male or female) develop in the ectoderm of the subumbrella wall of the stomach of the medusa. The medusa then lies with its mouth and velum uppermost in the gastrovascular cavity of its mother. Soon, however, it degenerates into a mere sac filled with genital products and thus ends the second generation. Stschelkanowzeff finds no nurse-cell in the early stages of development of the larvæ, such as Metschnikoff observed.

Stschelkanowzeff has shown that it is probable that the eggs from this second generation become free and develop into planula larvæ which attach themselves to the stomach or lips of the medusa *Geryonia*. Here they develop numerous medusa-buds, which are in turn set free and develop into *Cunina proboscidea*. It appears, then, that there are three generations of this medusa as follows:

I. The large free-swimming *Cunina proboscidea* having 9 to 14 tentacles.

II. The small 4-tentacled medusæ, which develop from the eggs of *C. proboscidea* and are found attached to the stomach-wall within the gastrovascular cavity of their mother.

III. The budding stolon-like larvæ, which develop from the eggs of the small, 4-tentacled medusæ and are parasitic upon the medusa *Geryonia*. The medusæ asexually set free from this parasitic larva are *Cunina proboscidea*.

As Stschelkanowzeff shows, Metschnikoff probably mistook the eggs of *C. proboscidea* for "spores." Stschelkanowzeff could find no asexual budding in the medusæ developing within the stomach-cavity of *C. proboscidea*, although this has been observed by Metschnikoff and also by H. B. Bigelow and by the author in other species. It is probable, however, that it is not of invariable occurrence. There is a marked discrepancy between the observations of Metschnikoff and those of Stschelkanowzeff in respect to the existence of the giant nurse-cells, but Bigelow finds them in *Pegantha smaragdina*, and indeed Stschel-

kanowzeff partially bridges the gap in his detailed account of the development of the oogonia and the oocytes and their nuclear phases. (See Zoolog. Centralblatt, Bd. 13, p. 676.)

The medusa larva which develops in the stomach *C. proboscidea* is attached to the maternal entoderm by means of two of its own ectoderm cells which send out processes into the entoderm of the mother medusa, thus constituting a very primitive placenta.

The genital cells of the larval medusa, in the stomach of its mother, originate from a single cell in the entoderm of the larva. This cell wanders into the ectoderm of the larva and there it divides to form the genital cells of the developing medusa.

Stschelkanowzeff's researches may be accepted with more reliance than those of Metschnikoff, for he bases his conclusions upon the study of serial sections, whereas Metschnikoff carried out his observations largely upon macerated material.

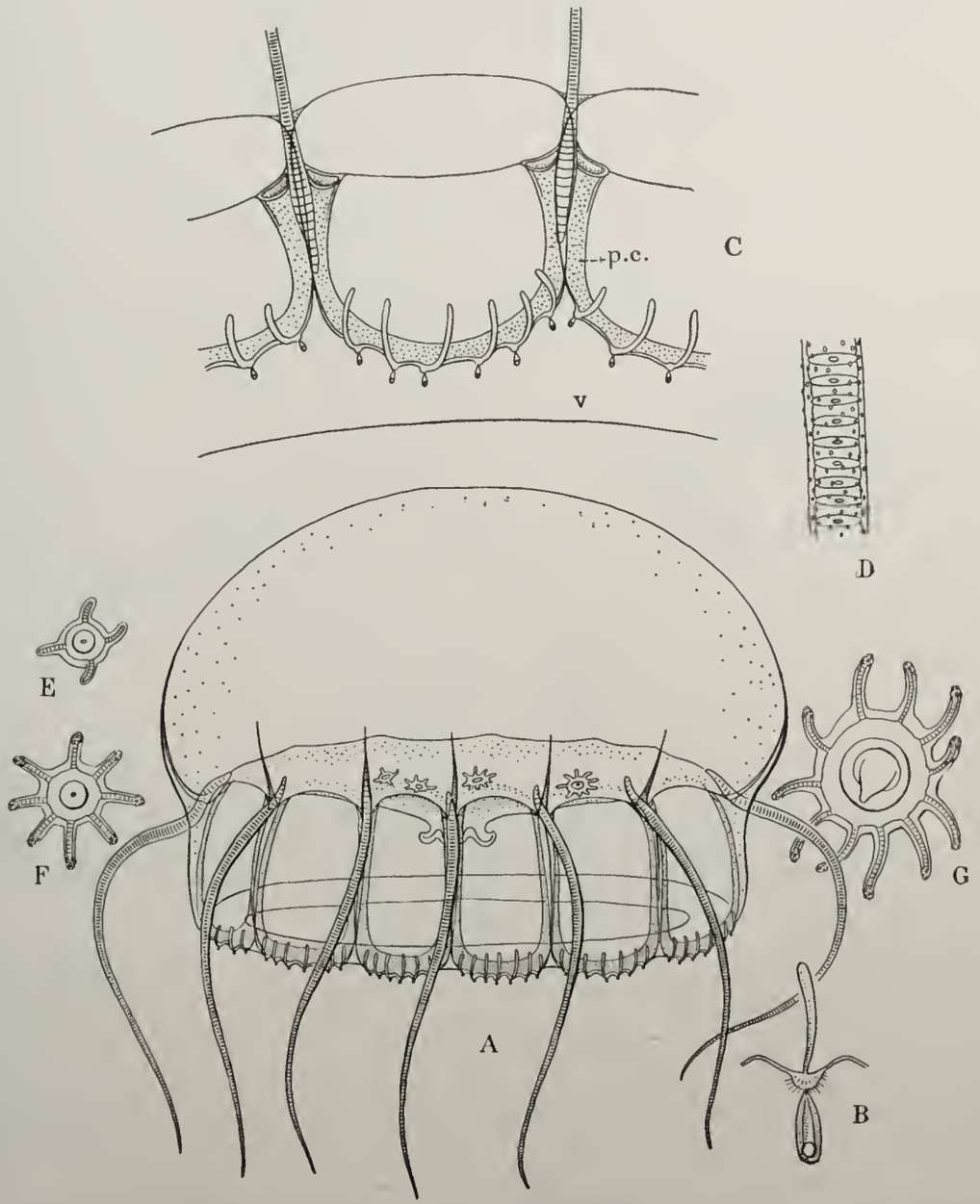

Fig. 319.—*Cunina prolifera*. *A*, Side view of mature medusa, with expanded bell-collar. *B*, One of the sensory-clubs and its otoporpa. *C*, Bell-margin; *v*, velum; *p. c.*, peronial ring-canal system. *D*, View of tentacle. *E*, *F*, *G*, Successive stages in growth of first sexual generation in stomach-cavity of swimming medusa. Drawn from life, by the author. Zoological Station, Naples, winter of 1907–08.

Cunina prolifera Gegenbaur.

Cunina prolifera, Gegenbaur, 1854, Generationswechsel bei Medusen und Polypen, p. 56, taf. 2, fign. 24–31, Würzburg; 1856, Zeit. für wissen. Zool., Bd. 8, p. 262.—Hæckel, 1879, Syst. der Medusen, pp. 313, 320.
Eurystoma rubiginosum, Kölliker, 1853, Zeit. für wissen. Zool., Bd. 4, p. 322.
Ægineta rosea, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 261, taf. 10, fign. 6, 7.
Cunina rhododactyla + C. rubiginosa, Hæckel, 1864, Jena. Zeitschr. für Naturwissen., Bd. 1, p. 335; Bd. 2, p. 263, taf. 9; 1865, Familie der Rüsselquallen, p. 125, taf. 6, fign. 78–85; 1879, Syst. der Medusen, pp. 313, 321.
Cunina rhododactyla, Metschnikoff, E., 1874, Zeit. für wissen. Zool., Bd. 24, p. 29, taf. 5 (development); 1886, Arbeit. Zool. Inst. Wien, Bd. 6, p. 252.—Maas, 1904, Résult. Camp. Sci. Prince de Monaco, fasc. 28, p. 32, plate 2, fig. 15.—Stschelkanowzeff, 1906, Mitth. Zool. Sta. Neapel, Bd. 17, p. 482.
Ægineta gemmifera, Keferstein und Ehlers, 1861, Zoolog. Beitrage aus Neapel und Messina, p. 93, taf. 14, fign. 10, 11.

The bell becomes 16.5 mm. wide. The gelatinous substance above the stomach is very thick and the aboral part of the bell is dome-like and evenly rounded. The bell-collar, on the other hand, is thin, flexible, and contractile. When expanded the lappets are about two-thirds as long as the bell-radius and their free, lower margins are evenly rounded. There are 4 to 8 sensory-clubs on each lappet. Each club arises by a very narrow stalk from a bristle-bearing pad on the bell-margin. The club contains at its distal end a single, red-colored, crystalline concretion of entodermal origin. A thick, linear otoporpa arises from the basal pad of each sensory-club and extends upward for a short distance over the exumbrella side of the lappet. The velum is well developed and provided with powerful, circular muscles.

The tentacles, and consequently the lappets, are remarkably variable in number, ranging from 7 to 16. There are usually 9 or more tentacles and lappets, but the actual number is so inconstant that there is no well-defined mean. Thus, among 36 medusæ studied by me at Naples during the winter of 1907–1908, 1 had 7 tentacles, none had 8, 7 had 9, 5 had 10, 6 had

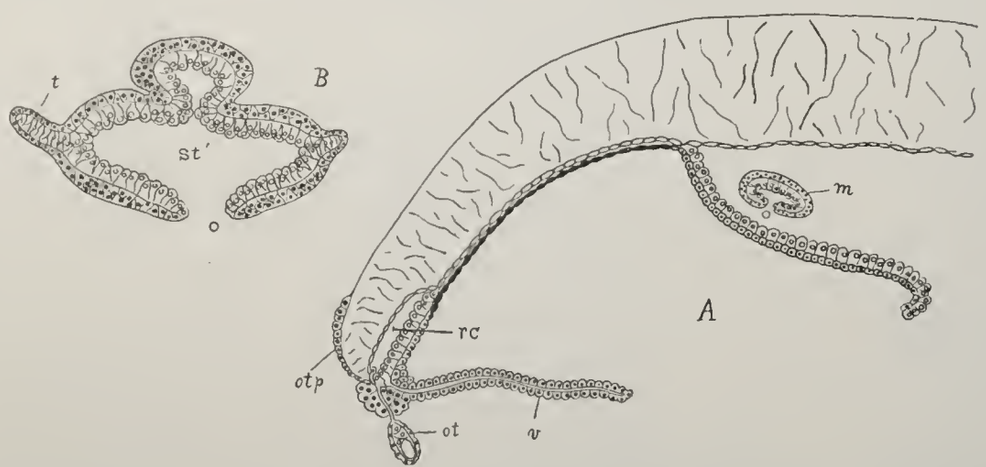

Fig. 320.—*Cunina prolifera*. Drawn by the author, from sections, at Naples Zoological Station. Ectodermal nuclei are shown as black dots while the entodermal nuclei are represented as circles. *A*, radial section through medusa in radius of sense-club; *m*, medusæ of first sexual generation floating in stomach-cavity of parent; *o*, mouth of young medusa; *ot*, sensory-club of the parent medusa; *otp*, otoporpa; *rc*, marginal ring-canal; *v*, velum. *B*, median section of one of the medusæ found in stomach-cavity of parent. This medusa is developing an aboral medusa-bud. *o*, mouth; *st*, stomach; *t*, tentacle.

11, 3 had 12, 5 had 13, 5 had 14, 1 had 15, 3 had 16. The tentacles taper gradually to their tips, are quite flexible, but not very contractile. They range in length from two-thirds to as long as the bell-radius. Their number does not increase with age in the free-swimming medusa, for large specimens often have a small number and young medusæ a larger number of tentacles. The rusty-red or port-wine color of the entoderm of the tentacles is very characteristic of this species. The tentacle-roots penetrate the gelatinous substance of the bell, so that there is a narrow, slit-like cleft in the side of the bell at the place of insertion of each tentacle.

The stomach is flat and lenticular and the mouth is a round opening with puckered lips at the extremity of a very short throat-tube, which never projects to the level of the velum. The marginal stomach-pouches, in the tentacular radii, are mere notches, rounded outwardly under the roots of the tentacles. The marginal, peronial, ring-canal system is well developed (see *p. c.* in text-figure 319 C.). The annular gonad is in the ectoderm around the margin of the subumbrella floor of the stomach.

A generation of medusæ is produced upon the stomach-wall of the parent medusa, the growing medusæ lying within the stomach-cavity. These young medusæ have at first 4, then 8, and finally about 11 to 16 tentacles. They have neither marginal sense-clubs, velum, nor bell collar, but in other respects they resemble the first sexual generation young of *C. proboscidea*. They give rise asexually to aboral medusa-buds one at a time. According to Stschelkanowzeff, 1905–06, the eggs of this first sexual (stomach-cavity) generation of *C. rubiginosa* are

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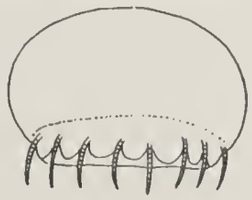
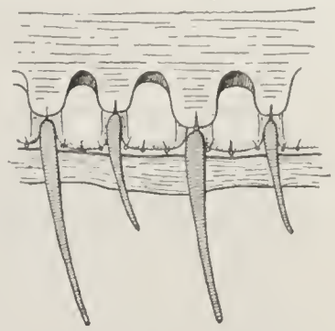


322.



323.

Fig. 321.—*Cunina prolifera*, after Keferstein and Ehlers, 1861 (*Æginета gemmifera*).
Fig. 322.—*Cunina prolifera*, after Gegenbaur, 1854. Bell-lappets contracted.
Fig. 323.—*Cunina duplicata*, after Maas, in Ergeb. Plankton Expedition.

set free into the ocean and develop into planula larvæ which attach themselves to the lips or gastric cavity of *Geryonia*. Here they grow into a stolon-like larva, which gives rise asexually to numerous medusa-buds, which on being set free grow into the large, free-swimming medusa we call *C. prolifera*.

C. prolifera is quite common in the Mediterranean during the winter, but is more abundant in spring.

Cunina peregrina Bigelow.

Cunina peregrina, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 59, plates 1, 15, 28, and 54.

Bell 14 mm. wide, highly arched, gelatinous substance thick, exumbrella smooth, excepting along the lines of the otoporpæ. 8 to 12 stiff tentacles, about as long as bell-radius. A prominent, peronial pad underlies the base of each tentacle. 4 to 8 sensory-clubs on each lappet. Each club contains a single concretion. The otoporpæ are narrower than in *C. globosa* and of nearly uniform width throughout their length. The marginal stomach-pouches are about as broad as long, square in outline, with very narrow clefts between them. There is no peripheral canal-system. The spermatozoa form ridge-like thickenings of the subumbrella gastric wall along the margins of the gastric pockets, but the ova are developed diffusely over the gastric pockets. There are powerful muscles in the subumbrella surface of the lappets. Colorless. Common on surface in eastern tropical Pacific.

Bigelow found a budding stolon attached to the subumbrella surface of *Rhopalonema velatum*, which was giving off medusæ resembling *C. peregrina*.

Cunina mucilaginosa De Blainville.

Medusa mucilaginosa, de Chamisso et Eysenhardt, 1821, Nova Acta Acad. Nat. Curios. Leop. Carol., tome 10, part 2, p. 360, tab. 30, figs. 2, A, B.
Cunina mucilaginosa, de Blainville, 1834, Man. d'Actinologie, p. 279.—Haeckel, 1879, Syst. der Medusen, p. 321.
Scyphis mucilaginosa, Lesson, 1843, Hist. Zooph. Acal., p. 282.
Solmaris mucilaginosa, Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 59.

See synoptic table of species of *Cunina*.

Vanhöffen finds that this medusa is represented among the captures of the *Valdivia*. Our knowledge of it is still quite imperfect.

Cunina duplicata Maas.

Cunina duplicata, Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 52, taf. 5, figs. 9, 10.

See synoptic table of species of *Cunina*.

Bell 20 mm. wide, quite similar to *Cunina lativentris* in shape. 16 tentacles, 8 large alternating with 8 small (young?). 3 sensory-clubs on each lappet, with sensory pads above

them. 16 marginal lappets alternating with the 16 tentacles. Peronial canals and a marginal ring-canal are present. Velum will developed. Stomach with 16 equally developed pouches in the radii of the 16 tentacles. 16 horseshoe-shaped gonads in the peripheral parts of the 16 stomach-pouches. South of the Cape Verde Islands in about 10° N. lat. off the African coast, from a depth of 500 fathoms. The 8 stomach-pouches in the radii of the 8 small tentacles are narrower and shorter than the 8 in the radii of the longer tentacles. The medusa is apparently immature.

Genus SOLMISSUS Haeckel.

Solmissus, Haeckel, 1879, System der Medusen, p. 349.—Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 63.

GENERIC CHARACTERS.

Similar to *Cunina* but without otoporpæ above the marginal sensory-clubs and without a marginal peronial canal-system.

The type species is *Solmissus albescens* of the Mediterranean.

*Synopsis of the Forms of Solmissus.**

	Solmissus albescens Haeckel.	Solmissus ephesius Haeckel, 1879, Syst. der Medusen, p. 350.	Solmissus faberi Haeckel, 1879, Syst. der Medusen, p. 350. =S. incisa?	Solmissus bleekii Haeckel, 1879, Syst. der Medusen, p. 351. =S. incisa?
Shape and size of bell in mm.	Lenticular, biconvex. 25 to 30 wide, 6 to 7 high.	Lenticular, biconvex. 10 wide, 5 high.	Lenticular, biconvex. 20 wide, 7 high.	Lenticular, biconvex. 40 wide, 10 bigh.
Number of tentacles, lappets and stomach-pouches.	14 to 16	12	24	32
Shape of stomach-pouches.	Pentagonal in shape. Somewhat wider than long.	5-angled, widest outwardly. Somewhat longer than broad.	Heart-sbaped, truncated. Wider outwardly. Somewbat wider tban long. Cleft by insertions of tentacles.	Rectangular, following outlines of lappets.
Shape of marginal lappets. Length in terms of tbe diameter of the central disk.	Nearly rectangular. One-fourth as long as radius of entire medusa, and 1.5 times as long as they are wide.	Wedge-shaped, somewhat longer than wide. One-fourth as long as diameter of entire medusa.	Rectangular, somewhat wider than long. One-fifth as long as radius of entire medusa.	Rectangular, twice as long as wide, about one-fourth as long as bell-radius.
Shape of central stomach and mouth.	Flat, lenticular, with rounded, simple mouth-opening.	?	?	?
Length of tentacles in terms of bell-radius (r).	$2r$	$3r$	r	r
Number of sensory-clubs on eacb lappet-margin.	5 to 8. No sensory tracts over exumbrella.	7. No exumbrella sensory tracts (otoporpæ).	3. No sensory tracts over exumbrella.	1. No sensory tracts over exumbrella.
Color.	Stomach-pouches and basal parts of tentacles whitish, other parts colorless.	?	?	?
Where found.	Mediterranean, common.	Coast of Asia Minor, Mediterranean.	Southwestern Atlantic. 26° W. long., 32° S. lat.	Atlantic coast of South Africa.
Remarks.		Is this a young stage of S. albescens?		Described from a single specimen by Haeckel.

*For *Solmissus marshalli* and *S. incisa* see text.

Solmissus albescens Haeckel.

Cunina albescens, Gegenbaur, 1856, Zeit. für wissen. Zool., Bd. 8, p. 260, taf. 10, fign. 3, 4.
Cunina moneta, Leuckart, 1856, Archiv. für Naturgesch., Jahrg. 22, p. 36, taf. 1, fig. 13; taf. 2, fig. 12.
Cunina solmaris, Hertwig, O. and R., 1879, Nervensyst. Sinnesorgane der Medusen, pp. 19, 34, taf. 1, fign. 7–10; taf. 10, fig. 6.
Solmissus albescens, Haeckel, 1879, Syst. der Medusen, p. 350.
Polyxenia albescens, Metschnikoff, E., 1886, Embryol. Studien an Medusen. Wien, pp. 23 (egg), 65 (formation of germ layers).

Bell flat, lenticular, 25 to 30 mm. in diameter. The central part of the bell is a doubly convex lens, quite thick at the center, whereas the bell-collar is thin, flexible, and contractile. The exumbrella over the collar region is thickly besprinkled with prickle-like tubercles and with flat, discoidal nematocyst-warts.

There are about 14 to 16 marginal lappets and an equal number of tentacles which alternate with these lappets. When expanded, each lappet is nearly rectangular, but with rounded angles on its outer margin; and it is about 1.5 times as long as it is wide. They can, however, contract so as to become somewhat wider than they are long. There are 5 to 8 sensory-clubs on the margin of each lappet. There are neither otoporpæ nor exumbrella sensory tracts above the sensory-clubs. Each sensory-club is short and widens outwardly, with a cup-shaped entodermal cavity in its outer end within which there is a vesicle containing a spherical concretion. The outer half of the sensory-club bears sensory bristles.

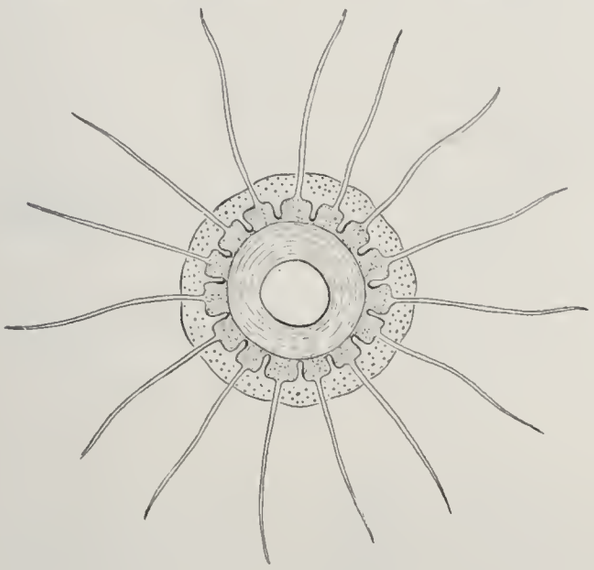


Fig. 324.—*Solmissus albescens*, after Gegenbaur, in Zeit. für wissen. Zool., Bd. 8.

The annular velum is broad and has powerful circular muscles. The 14 to 16 tentacles are each nearly as long as the bell-diameter. They taper gradually from the sides of the bell to their tips and are not very flexible, bending commonly only near their bases. The central stomach is a wide space with a very widely-gaping, circular mouth-opening. The convex lower floor of the central disk projects downward into the stomach-cavity; and indeed the stomach-wall simply forms an annulus around it, the mouth being constantly open. The marginal stomach-pouches are pentagonal in shape and somewhat wider than they are long. Their outer angles lie under the roots of the tentacles. Sections stained in Delafield's hæmatoxylin show there is no marginal canal-system. The gonad is developed over the subumbrella ectoderm of the stomach-pouches and stomach.

The gonads and tentacles are slightly milky in color, the concretions are garnet-red, and all other parts are colorless.

This medusa is quite common in the Mediterranean, having been found frequently at Naples and Messina.

The dimensions, in mm., of a specimen studied by me at Naples are as follows: Diameter of bell, 28; width of central stomach, 18.5; width across stomach and stomach-pouches, 22.5; tentacles 25 ± long. (See text-figures 325 and 326.)

Solmissus incisa Bigelow.

Solmaris incisa, Fewkes, 1886, Report Commiss. Fish and Fisheries U. S. A. for 1884, p. 954, plate 9; 1889, *Ibid.*, p. 529.—Maas, 1893, Ergeb. der Plankton Expedition, Bd. 2, K. c., p. 47.
Solmissus incisa, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 67, plate 21, figs. 1–3, 5.

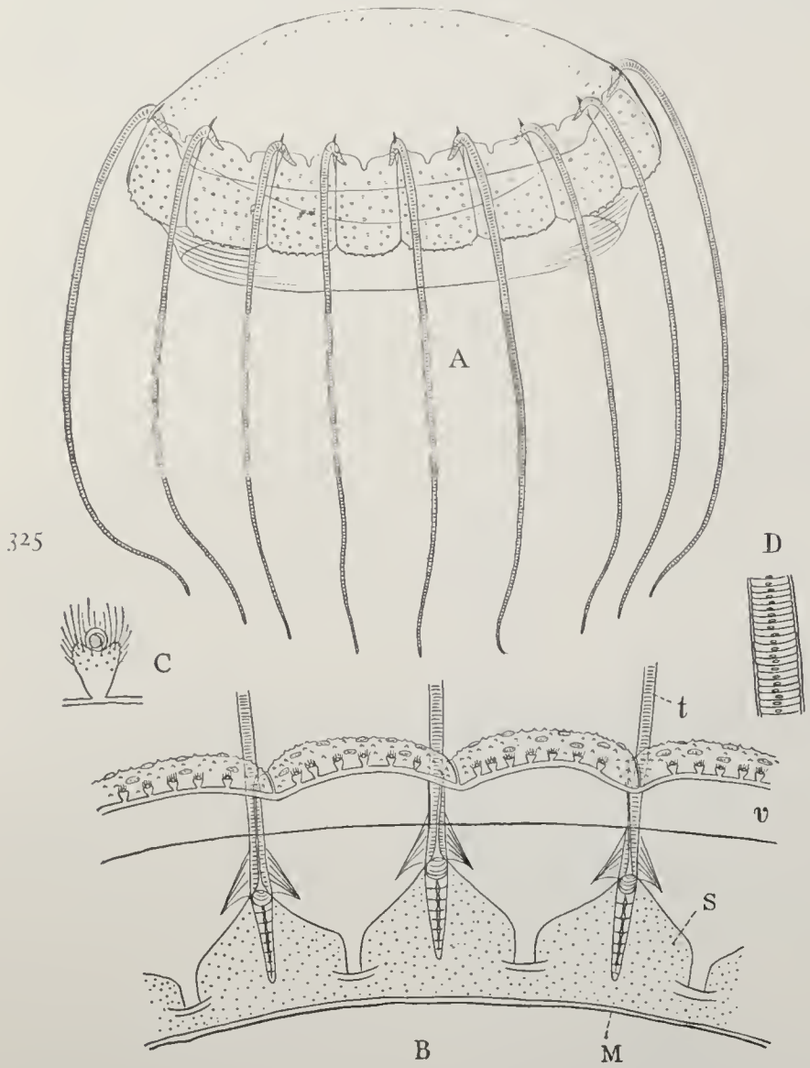
Bell 75 mm. wide, flat, exumbrella smooth. Gelatinous substance very soft and thinner than in *S. marshalli*. 18 to 32 stiff, tapering tentacles, longer than the bell-diameter. Not more than 2 to 5 sensory-clubs per lappet. Clubs similar to those of *S. albescens*. Tropical Pacific and Atlantic Gulf Stream. Distinguished from *S. marshalli* by its soft, gelatinous substance, fewer sense-clubs, and greater number of tentacles. It is possibly identical with *S. faberi* and *S. bleeki* of Haeckel.

Solmissus faberi Haeckel.

Solmissus faberi, Haeckel, 1879, Syst. der Medusen, p. 350.

Bell lenticular, biconvex, 20 mm. wide and 7 mm. high. 24 tentacles hardly as long as bell-radius. 72 sensory-clubs without otoporpæ. 3 on each bell-lappet; the 24 lappets form a

collar around the bell; they are rectangular, somewhat wider than long, and hardly one-fourth as long as bell-height. 24 radially situated, heart-shaped stomach-pouches have their wide ends outward, somewhat wider than long, and contain the gonads. The tentacle-bases are inserted into the clefts of the heart-shaped diverticula of the stomach.



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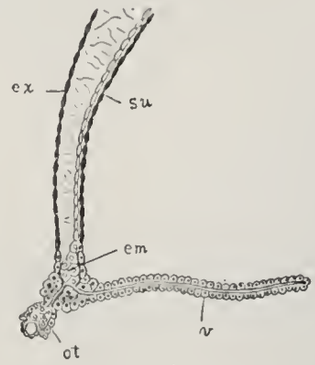

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Fig. 325.—*Solmissus albescens*. *A*, Side view of mature medusa. *B*, Bell-margin; *v*, velum; *t*, tentacle; s, stomach-pouches; *m*, mouth. *C*, Sensory-club. *D*, Tentacle. From life, by the author. Naples Zoological Station, January 16, 1908.

Fig. 326.—*Solmissus albescens*. Radial section of the bell-margin through a sensory-club. Drawn by the author, from a medusa from Naples, Italy. Nuclei of ectodermal cells are shown as black dots, while those of entoderm are represented as circles. *em*, solid cord of entoderm cells at the bell-margin; *ex*, exumbrella; *ot*, sensory-club; *su*, subumbrella; *v*, velum.

This medusa is found in the southwestern Atlantic, S. lat. 32°, W. long. 26°. It is described by Haeckel from preserved specimens and is possibly identical with *S. incisa*.

Solmissus marshalli Agassiz and Mayer.

Solmissus marshalli, Agassiz and Mayer, 1902, Mem. Museum Comp. Zool. at Harvard College, vol. 26, p. 151, plate 5, figs. 23-25.—Bigelow, H. B., 1909, *Ibid.*, vol. 37, p. 64, plates 16 and 17.
Solmaris flavescens, Vanhöffen, 1908, Narcomedusen der *Valdivia* Expedition, p. 58, taf. 2, fign. 9, 10; taf. 3, fign. 20–22.
Solmaris punctatus, Mayer, 1906, Bull. U. S. Bureau of Fisheries, p. 1133.

This species was inadequately described by Agassiz and Mayer, but has been rescued from scientific oblivion through an excellent description by Bigelow.

Bell 62 mm. wide, flat, half as high as wide, and exumbrella smooth. Gelatinous disk thick and rigid, marginal lappet-zone very thin. Lappets rectangular, as broad as long, with margins hardly, if at all, incised in the peronial radii. 8 to 16 long, stiff, tapering tentacles as

long as bell-diameter. As many as 15 sensory-clubs per lappet in large specimens, 7 to 10 in medium sized medusæ. The sensory-clubs resemble those of *S. albescens*. The stomach-pouches are rectangular and slightly longer than wide. No peronial canals. Female gonads confined to the subumbrella margins of the gastric pouches in the ectoderm of the thin stomach wall. The eggs are very large. The male gonads are developed more evenly over the surface of the gastric pouches. Colorless or with slightly yellowish entoderm. Found in tropical Pacific on the surface by Bigelow. Vanhöffen describes this medusa under the name *Solmaris flavescens* from the *Valdivia* collections made off the tropical Atlantic coast of Africa and in the Indian Ocean and Gulf of Aden.

It is distinguished from *S. albescens* of the Mediterranean by its smooth exumbrella, rectangular stomach-pouches and large number of sensory-clubs.

Vanhöffen's "*Solmaris rhodoloma*" appears to be a form of *Solmissus* but his specimens were imperfect (see 1908, Narcomedusen der *Valdivia* Expedition, p. 60, taf. 1, fig. 5).

Genus CUNISSA Haeckel, 1879, sens. ampl.

Cunissa+Æginodorus, Haeckel, 1879, Syst. der Medusen, pp. 322, 344.
Cunissa, Maas, 1906, Fauna Arctica, Bd. 4, Lfg. 3, p. 497.

The type species is *Cunissa polyporpa* Haeckel, from the Indian Ocean.

GENERIC CHARACTERS.

Æginidæ with 9 or more peronial strands and an equal number of tentacles. The primary peripheral stomach-pouches are equal in number to the tentacles, but are cleft by the insertions of the tentacles so as to appear to be twice as numerous as the latter.

Haeckel states that *Cunissa* is closely related to *Cunina*, but in *Cunina* the peripheral stomach-pouches are not cleft by the insertions of the tentacles, and it would seem that *Cunissa* is analogous to *Ægina* and *Ægineta*, where we find such cleft pouches.

Æginodorus Haeckel is only a special case of *Cunissa* wherein there are 16 tentacles. Haeckel places Forbes's *Polyxenia alderi* in the genus *Æginodorus*. This was described by Forbes from an erroneous figure by Alder. It may be a *Pelagia*, but is so vaguely determined that it seems best to omit it from further consideration.

Æginorhodus Haeckel is even more vaguely described and Haeckel himself admits (*Challenger* Report Deep-sea Medusæ, 1881, p. 1) that his specimen is too imperfect for description.

Synopsis of Species of Cunissa.

	C. polyporpa Haeckel, 1879, p. 322.	C. polyphera Haeckel, 1879, p. 323.
Shape and size of bell in mm.	Hemispherical. 20 wide, 10 high.	Flat, shield-shaped. 30 wide, 10 high.
Number and shape of marginal lappets.	16. Semicircular, hardly one-sixth as long as radius of central lenticular part of bell.	32. Oval, hardly one-fourth as long as radius of central lens.
Number of tentacles and peronial strands.	16. Tentacles short, hardly longer than lappets.	32. Tentacles not quite as long as diameter of central lens.
Number and shape of peripheral stomach-pouches.	16. Cleft by 16 tentacles to give 32 peripheral pouches. These peripheral pouches are rectangular and *half* as long as the 16 primary, basal parts of pouches.	32. Cleft lappets, giving 64 terminal pouches; widening outwardly.
Number of sensory-clubs on each lappet.	12 to 15	5 to 7
Position of gonads.	Upon stomach and pouches.	64 gonads in terminal pouches of lappets.
Color.	?	?
Where found.	Singapore, Indian Ocean.	Zanzibar, Indian Ocean.

Genus ÆGINODISCUS Haeckel, 1879.

Æginodiscus, Haeckel, 1879, Syst. der Medusen, p. 344.

The only form is the little-known *Æginodiscus actinodiscus* Haeckel, from the coast of Zanzibar. A further study of this form is required before the genus can be accepted with certainty.

GENERIC CHARACTERS.

Æginidæ having 16 peronial strands, 8 tentacles, and 32 (16 cleft) peripheral stomach-pouches.

Æginodiscus actinodiscus Haeckel.

Æginodiscus actinodiscus, Hafckel, 1879, Syst. der Medusen, p. 344.

This medusa is briefly described by Haeckel, without figures, from a preserved specimen. The bell is lenticular, 40 mm. wide, 13 mm. high. 16 peronial strands, 8 tentacles 3 times as long as the bell-radius. Four 3-cornered lips. There are 32 (16 cleft) rectangular peripheral stomach-pouches, each one-third as long as the bell-radius. Gonads developed in the ectoderm of the subumbrella under the stomach-pouches. Zanzibar, Indian Ocean.

APPENDIX.

Pennaria disticha (see page 24).

Pennaria cavolini, Goette, 1907, Zeit. für wissen. Zool., Bd. 87, p. 46, taf. 4, 5, fign. 85–96.—Campenhausen, 1896, Zool. Anzeiger, Bd. 19, p. 104 (hydroid from Ternate).

Goette discusses the development of the germ cells and of the medusa-buds.

Cerfontaine, 1902 (Archiv. de Biologie, tome 19, p. 251, planches 8–9), gives an elaborate account of regeneration and heteromorphosis in *Pennaria* from Naples.

Pennaria tiarella (see page 25).

Pennaria, Smallwood, 1909, Biol. Bull. Woods Hole, vol. 17, p. 219, plates 1-4.
(?) *Pennaria symmetrica*, Thornely, 1908, Journal Linnean Soc. London, vol. 31, Zool., p. 81, from Shab al Shubuk and the quay-side of Suakim, Red Sea.
(?) *Pennaria inornata*, Brooks, 1882, Studies Johns Hopkins Biol. Lab., vol. 2, p. 144.

Miss Smallwood finds that, before the eggs are mature and while still within the medusa or shortly after being cast out, a membrane which is apparently fluid or gelatinous appears around the egg. This is only a temporary structure, however, and is replaced by the true membrane which forms after fertilization and the beginning of cleavage. Maturation begins and fertilization may take place before the egg is cast out into the water. The polar bodies and apparently all subsequent cleavages are formed by the mitotic process. The sperm head is transformed into the male pro-nucleus. After the two polar bodies are formed a considerable amount of chromatin migrates into the cytoplasm, being transformed into vesicles which are eventually taken up by the cytoplasm itself. There is a distinct centrosphere. The new prophase spindle arises within the old centrosphere. Inclusions are often found in the immature egg, but these are not seen during the segmentation stages.

Pennaria vitrea Agassiz and Mayer (see page 28).

Pennaria vitrea, Bigelow, H. B., 1909, Bull. Mus. Comp. Zool. at Harvard College, vol. 37, p. 186, plate 7, fig. 4.

Bigelow found a single specimen of this medusa near Easter Island, tropical Pacific. It was 4 mm. high and 3 mm. in diameter. The tentacle-bulbs were yellowish and the manubrium milky.

Sarsia resplendens Bigelow = S. eximia (?).

Sarsia resplendens, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 181, plates 7 and 40.

Bell 2 mm. high, 1.5 mm. wide, rounded, with uniformly thin walls. 4 tentacles only half as long as bell height and bearing 6 to 10 prominent, non-ringed, nematocyst swellings. Each tentacle terminates outwardly in a spherical pad. Tentacle-bulbs swollen and with large abaxial ocelli. Manubrium only about half as long as depth of bell-cavity. Mouth a round opening. Gonad encircles manubrium from base almost to the lip. No axial canal above stomach. Near the base of the manubrium are 8 adradial spots of vermillion and yellow pigment granules. Entoderm of tentacles vermillion with a spot of ochre-yellow in tentacle-bulbs. Ocelli black. Acapulco Harbor, Pacific coast of Mexico. This medusa bears so close a resemblance to *Sarsia eximia* (page 57) that I am inclined to suspect that it may be identical with the well-known Atlantic medusa. It may possibly be distinguished by its knobbed tentacles and its yellow and red color.

Sarsia coccometra Bigelow.

Sarsia coccometra, Bigelow, H.B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 179, plates 7, 40, and 43.

Bell 5 mm. high, 4 mm. wide, with thin walls and pointed apex. 4 tentacles twice as long as bell-height and ringed with prominent nematocyst swellings. The outer end of each tentacle is swollen, knob-like, and covered with nematocysts. The tentacle-bulbs are swollen and each has a black, abaxial ocellus. 4 slender radial-canals and a short axial canal above the stomach. Manubrium as long as depth of bell-cavity and entirely encircled by the gonad, leaving only the short throat-tube free. The eggs are very large. Gonads reddish and tentacle-bulbs Vandyke-brown. Pacific coast of Central America.

This form somewhat resembles *Sarsia eximia* of the Atlantic, California, and Alaskan waters, but appears to be distinguished by its apical projection, axial canal, and knobbed tentacles.

Syncoryne sarsii (see page 52).

Syncoryne sarsi, Goette, 1907, Zeit. für wissen. Zool., Bd. 87, p. 35, taf. 4.

Goette gives a detailed account of the development of the medusa-buds. The sperm originates and remains in the ectoderm, but the egg-cells originate in the entoderm of the stomach-region of the spadix and afterwards migrate into the ectoderm.

Sarsia pulchella (see page 57).

Sarsia pulchella, Hartlaub, 1907, Nordisches Plankton, Craspedote Medusen, p. 109, 1 fig.

Hartlaub figures a twin monster of *Sarsia* with two bell-margins. The bell cavities appear to be connected by a transverse canal, but the two gastrovascular systems are separate. Double monsters have been seen in *Bougainvillia carolinensis* and *Pseudoclytia pentata*.

Ectopleura dumortieri (see page 69).

Ectopleura ochracea, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 184, plates 6 and 38.

Bigelow found many specimens of this medusa in Acapulco Harbor, Pacific coast of Mexico. It appears to be identical with *E. ochracea* of the southern coast of New England, and this form I was unable to distinguish from *E. dumortieri* which I found in the English Channel in 1907.

Genus Mœrisia Boulenger, 1908.

Mœrisia, Boulenger, 1908, Quarterly Journal Microscop. Science, vol. 52, p. 358.

The type species is *Mœrisia lyonsi* Boulenger, from the brackish Lake Qurun which communicates with the Nile in the Fayum province of Egypt.

The medusa resembles *Sarsia* but the gonad extends outward from the sides of the stomach along the 4 radial-canals. The hydroid has a single circlet of *hollow* tentacles and produces medusa-buds and asexual planula-like buds upon the sides of the hydranths.

The hydroid resembles *Hydra* and departs from all other hydroids in having hollow tentacles.

Mœrisia lyonsi Boulenger.

Mœrisia lyonsi, Boulenger, 1908, Quarterly Journal Microscop. Science, New Ser., vol. 52, p. 357, plates 22, 23; 1909, Proc. Cambridge Philosoph. Soc., vol. 15, p. 180 (migrations of nettling-cells).

This interesting medusa and its hydroid are described in detail by Boulenger from the brackish lake Qurun, the remains of the historic Lake Mœris which was in ancient times used as an artificial regulator of the Nile. It is in the Fayum province of Egypt, and it is probable that this medusa is a survivor of the fauna of the Pliocene sea which once covered the Fayum depression.

The medusa resembles *Sarsia* but the gonads extend outward from the stomach-walls along the 4 radial-canals. Bell globular, thick-walled, 4.5 mm. wide and about 4 mm. high.

Bell-cavity about half as deep as bell-height. 4 tapering tentacles with swollen basal-bulbs each bearing an ectodermal ocellus on its outer side. The tapering shafts of the tentacles are about 1.5 times as long as the bell-diameter and are armed with numerous, bead-like, swollen rings of nematocysts. Velum well developed. 4 simple, narrow radial-canals. Manubrium short, simple, conical, with a round mouth-opening without prominent lips. The gonad encircles the ectodermal wall of the stomach and as growth proceeds the thick, ectodermal, germinal epithelium extends outward along the 4 radial-canals, forming 4 diverticula as in *Dissonema*, and extending half-way down each radial-canal. Males only were observed.

The hydroid grows in colonies at a depth of 6 to 15 feet in Lake Qurun where it usually occurs upon *Cordylophora*. The hydrorhiza is a short, stolon-like tube, the free end of which usually narrows out to form a hydranth-bearing stem. It also gives off in an irregular manner filiform branches about 10 mm. long, each of which terminates in a polypite over 2 mm. long. Only the proximal parts of the branches are covered by the annulated perisarc, the distal ends being quite naked and flexible so that they become entwined around the *Cordylophora*. The hydranths are claviform with about 4 or 5 *hollow*, filiform tentacles, although these may range from 0 to 8. These tentacles arise in a single circlet from the widest part of the polypite and are very contractile. The hypostome is cylindrical, not constricted at its base. Medusa-buds develop from the sides of the body of the hydranth, both above and below the circlet of tentacles. In addition to the production of medusæ, hernia-like outgrowths involving both ectoderm and entoderm appear upon the side walls near the bases of the hydranths and are cast off to form asexual buds. They may develop tentacles before being cast off.

This hydroid resembles *Hydra* and differs from all other hydroids in having hollow tentacles. It bears a certain apparently superficial resemblance to *Bougainvillia*. The hydroid and medusa have 4 kinds of nematocysts.

Boulenger studied the variations of 400 specimens of the medusa. One specimen had 3 canals, gonads, and tentacles, nine had 5, and one had 6 of these structures. Forty-four of the medusæ had 4 canals and gonads, but their tentacles ranged in number from 5 to 22. Of these, 28 medusæ had 16 tentacles each, and one had 22. The medusæ appear in May in Lake Qurun.

Slabberia brownei.

Dipurena sp. (?), Browne, 1905, Pearl Oyster Fisheries, Gulf of Manaar, p. 133, plate 2, figs. 1, 2.
Purena brownei, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 183, plates 7 and 44.

Bell 5 mm. in diameter, dome-like, rounded, without an apical projection, walls rather thick. 4 tentacles much longer than bell height, with globular basal-bulbs imbedded in the gelatinous substance and surrounded basally by an encircling swelling bearing a prominent ocellus on its outer side. Near the tentacle-bulbs the tentacles are smooth, but outwardly they bear oval, transversely placed, non-ringed clusters of nematocysts. Manubrium 1.5 to 3 times as long as the depth of the bell-cavity. Stomach barrel-shaped. Mouth a round opening. From 1 to 5 ring-like gonads encircling the narrow, tubular part of the manubrium above the stomach. Ocelli yellowish, gonads opaque white. From Ceylon and Manga Reva to Acapulco Harbor, west coast of Mexico.

Zanclea gemmosa McCrady (see page 88).

Zanclea gemmosa, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 188, plates 7 and 44.

Bigelow records the capture of five specimens of this medusa in Acapulco Harbor, Pacific coast of Mexico.

Heterotiara anonyma Maas (see page 107).

Heterotiara anonyma, Bigelow, H. B., 1909, Mem. Museum Comp. Zool. at Harvard College, vol. 37, p. 216, plate 41.

Bigelow records two specimens of this medusa from off the coast of Peru, in the Humboldt Current. One had 11 and the other 12 tapering tentacles without basal-bulbs. Gonads interradial, entirely separated in the perradii and without cross-furrows. Gonads opaque yellowish, other parts colorless. Bell 20 mm. in one and 22 mm. high in the other specimen; both 20 mm. wide. In other respects the specimens resembled the form described by Maas.

Perigonimus vagans Thornely.

Perigonimus vagans, Thornely, 1908, Journal Linnean Soc. London, Zool., vol. 31, p. 81, plate 9, fig. 1.

Colony much branched, 35 mm. high. Branches alternate in origin, but inclining all to one side, narrower than the main stem and narrowest at base where there are a few corrugations. Perisarc covered with sand. Some small polypites with few tentacles, some larger on longer stalks with about 25 tentacles. Both sizes carry gonophores. Each gonosome contains a single medusa. Khor Shinab, Sudanese Red Sea, 10 to 12 fathoms. Free medusa unknown.

Stomotoca octaedra (see page 111).

Amphinema australis, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 199, plates 7 and 38.

Bigelow separates *Amphinema* from *Stomotoca* on the ground that the former lacks a gelatinous peduncle while this is found in *Stomotoca*. In life, however, the peduncle of *Stomotoca pterophylla* varies greatly in size, dependent upon the state of contraction of the medusa. When contracted it is prominent but when the bell is fully expanded it becomes so broad and flat as to be nearly indistinguishable. It would appear to me, therefore, to constitute a somewhat uncertain character upon which to base generic distinctions.

Bigelow has found many specimens of *S. "australis,"* which I suspect is identical with *S. octaedra*, in Acapulco Harbor, Pacific coast of Mexico on the surface. It was previously known only from the Atlantic. Bigelow finds that the 4 gonads are interradial, with smooth, external surfaces.

Stomotoca divisa Maas (see page 114).

Stomotoca divisa, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 203, plates 7 and 43.

Bigelow finds that the gonads originate as interradial, horse-shoe-shaped swellings on the sides of the manubrium but that later the interradial connections disappear and we find 8 adradial gonads entirely separated in both perradii and interradii. I find that the gonads of *Stomotoca pterophylla* go through the same developmental stages (plate 29, fig. 4). Bigelow's specimens were from Acapulco and from the Galapagos Islands, tropical Pacific.

Dissonema turrida Mayer (see page 116).

Amphinema turrida, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 200, plates 7, 40, 43, and 44.

Bigelow found four specimens of this medusa upon the surface in Acapulco Harbor, Pacific coast of Mexico. He has discovered that the gonads originate as 4 interradial, horse-shoe-shaped bodies upon the sides of the manubrium and resemble those of Pandea and Turris with definite, transverse folds. Later the perradial walls of the manubrium grow outward along the radial-canals and thus the gonads come *secondarily* to lie along the radial-canals as well as on the interradii of the manubrium. He therefore corrects Mayer's erroneous account of 1900. Bigelow thus demonstrates that this genus is closely related to *Stomotoca* and indeed he prefers to consider it as an *Amphinema*. As he states, it may prove to be identical with Haeckel's *Codonorchis octaedrus*, and if this be true *Stomotoca australis* is a distinct species (see page 111).

Dendroclava dohrni (see page 117).

Dendroclava dohrni, Goette, 1907, Zeit. für wissen. Zool., Bd. 87, p. 42, taf. 4, fign. 78–84.

The egg cells of *Dendroclava* first appear in the ectoderm of the inner part of the bell-cavity which later becomes the outer epithelium of the manubrium. The gonads are found in 4 interradial, swollen regions of the ectoderm of the manubrium.

Zoja, 1892 (Annals and Mag. Nat. Hist., ser. 6, vol. 9, p. 409), who describes the appearance and habits of the living hydroid, concludes that it is probably related to *Turris*.

Pandea violacea Agassiz and Mayer (see page 119).

Pandea violacea, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 205, page 41, figs. 10, 11.

Bigelow found seven specimens on the surface in Acapulco Harbor, Pacific coast of Mexico. None of his specimens was more than 4 mm. high, and had only 8 well-developed and 8 small tentacles. Bigelow corrects Mayer's account of the gonads for he finds that they

are 4 interradial, horse-shoe-shaped swellings with smooth, outer surfaces without transverse folds. He states, however, that he suspects that the gonads are continuous in the perradii also, thus resembling in this respect the condition seen in *Pandea conica*.

This medusa appears to be found in the tropical Atlantic and Pacific Oceans, and in the Mediterranean.

Genus "Turris" = Clavula. (see page 120).

The generic name *Turris* is preoccupied. It was first used by Humphrey, 1797, for mollusca. *Tiara* is also preoccupied for mollusca, having been used in 1830 by Menke. *Clavula* used by Wright, 1859, to designate the hydroid of Lesson's *Turris neglecta* must be used to describe the medusæ called "*Turris*" and "*Tiara*" by Lesson, 1843.

Clavula fontata.

Turris fontata, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 209, plates 39 and 42.

Bell 22 mm. high, higher than wide with a low, dome-like, apical projection and thin side walls. 16 large, 5 intermediate, and about 40 small tentacles. Basal-bulbs of large tentacles laterally compressed and with spurs which curve over the exumbrella surface above the bell-margin. The bulbs of the small tentacles contain pigment spots composed of scattered granules, but these are absent or feebly developed in the large tentacles. A remarkable feature in this species is that an opening occurs on the outer side of each large tentacle-bulb, connecting the entodermal cavity of the tentacle with the outer world. In addition to these ostia of the tentacle-bulbs, there is an ectodermal pit in the exumbrella above the basal spur of each large tentacle. These pits are apparently sensory and are lined with ectodermal bristle cells. The 4 radial-canals are wide and their edges bear glandular diverticulæ throughout their lengths. These diverticulæ may or may not be branched and resemble those of *C. cocca*. The margin of the circular canal is somewhat jagged, but bears no diverticula. The radial-canals are very deep basally where they join the stomach. The manubrium is long and the complexly folded lips extend nearly to the level of the velar opening. The gonads resemble those of other species of the genus. Gonads deep orange, manubrium and tentacles pale ochre-yellow, bell hyaline and bluish. A single perfect specimen is described by Bigelow from off the Pacific coast of Lower California.

This species is distinguished by its exumbrella sensory-pits and the ostia in its tentacle-bulbs.

Clavula papua (see page 125).

Tiara papua, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 207, plate 42, figs. 1 to 4.

Bigelow records this species from Easter Island, the coast of Peru, and Mexico. He makes it evident that *T. oceanica* Agassiz and Mayer is a synonym of *C. papua*.

Sibogita typa (see page 131).

Calycopsis typa, Fewkes, 1882, Bull. Museum Comp. Zool. at Harvard College, vol. 9, p. 304, plate 1, fig. 34.
Sibogita nauarchus, Bigelow, H. B., 1909, *Ibid.*, vol. 52, p. 206, figs. 1–8.

"*Calycopsis typa*," inadequately described and figured by Fewkes, is undoubtedly identical with *Sibogita* "*nauarchus*" which has recently been carefully studied and well figured by Bigelow. Both medusæ are from the Gulf Stream off the coast of the United States. Form of bell, gonads, tentacles, and manubrium identical in both and number of radial-canals and tentacles practically the same, although Fewkes is apparently in error in believing that the interradial and adradial canals connect with the stomach. It is possible, however, that this occurs when the medusa approaches maturity.

The following description is derived from Bigelow's account of the medusa: Bell dome-shaped, 37 mm. high, 40 mm. wide. Gelatinous substance fairly thick and rigid. The bell shows a marked lateral flattening due apparently to a phase of contraction, for it may be radial or interradial. There are 4 radial-canals and from 3 to 5 blindly-ending centripetal canals in each quadrant. Interradial canals reach nearly to base of stomach but do not connect

with it, and the other canals are shorter. There are typically as many tentacles as there are canals, but as the tentacle begins to develop before its canal they may appear more numerous. Thus in Bigelow's specimens the tentacles ranged from 22 to 25 while the canals ranged from 18 to 21. When they first appear the tentacles arise from the bell-margin but later turn outward and upward so that they appear to emerge from the sides of the bell above the margin, but the exumbral furrows connecting the tentacles with the margin remain open grooves. Tentacles hollow, longer than bell-height, and when fully grown there is a well-developed terminal nematocyst-knob.

Manubrium wide and barrel-shaped, two-thirds as broad as long, and half as long as depth of bell-cavity. Its base is cruciform. The 4 gonads are upon the interradial sides of the stomach, and each one consists of a double series of narrow, regularly spaced transverse folds. Gonads deep brownish-red, terminal knobs of tentacles pale yellowish. In the Gulf Stream off the southern coast of New England, between 175 fathoms and the surface, being apparently a member of the intermediate fauna.

Cytaeis vulgaris Agassiz and Mayer (see page 134).

Cytaeis vulgaris, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 190, plates 6, 40, and 43.

Bigelow presents good evidence tending to show that *C. herdmani* of Browne, 1905, from Ceylon is identical with *C. vulgaris* of the tropical Pacific. Bigelow's largest specimens were 5 mm. in diameter and had 42 oral tentacles. All of his larger specimens were developing medusa-buds upon their manubria. The entodermal core of the tentacles and tentacle-bulbs was deep salmon or chocolate-red and the manubrium pale salmon-red. Bigelow records it from 300 fathoms to the surface between Manga Reva and the Galapagos.

Podocoryne carnea (see page 136).

Podocoryne carnea, Goette, 1907, Zeit. fur wissen. Zool., Bd. 87, p. 5, taf. 1–3, fign. 1–63.

Goette gives a detailed account of his studies of the development of the medusæ, the origin and migrations of the germ cells, and the development of the sperm. His account of the processes involved in the development of the medusa-bud is the most complete yet published. The ring-canal is not formed by side branches at the terminal ends of the 4 radial-canals, but by irregular fusions at the ends of the 4 entodermal pouches which eventually form the radial-canals.

Podocoryne anechinata Ritchie.

Podocoryne anechinata, Ritchie, 1907, Proc. Zool. Soc. London, p. 499, plate 23, figs. 8–10.

This form is distinguished by the fact that its hydrorhiza consists of a single layer of chitinous tubes forming wide, rectangular meshes, the individual tubes being almost 0.1 mm. in diameter and bearing honey-yellow colored chitinous thickenings at fairly regular intervals in their side walls. The whole network is covered by a thin layer of cœnosarc, but there are no spines.

The nutritive zooids are club-shaped, only 0.9 mm. high, and with about 9 tentacles in two closely set rows. The reproductive polypites are swollen and have about 7 tentacles. Medusæ have 4 blunt tentacles when set free.

Porto Praya, Santiago, Cape Verde Islands, in 5 fathoms, August.

Lymnorea alexandri Mayer (see page 154).

Lymnorea alexandri, Bigelow, H. B., 1909, Mem. Mus. Comp. Zool. at Harvard College, vol. 37, p. 193, plates 40 and 44.

Bigelow records this species from Acapulco Harbor, Pacific coast of Mexico. He obtained 4 specimens, the largest being 2.5 mm. high and nearly 2.5 mm. wide, and with 46 marginal tentacles. Previous accounts record this medusa from the West Indian region.

Bougainvillia fulva Agassiz and Mayer (see page 160).

Bougainvillia fulva, Hartlaub, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 448, taf. 19, fign. 1–4.

2 specimens from Djibuti, east coast of Africa.

Bougainvillea fruticosa (see page 160).

Bougainvillea fruticosa, Goette, 1907, Zeit. für wissen. Zool., Bd. 87, p. 39. taf. 4, fign. 72–77.

Goette finds that the egg-cells in this medusa originate in the entoderm and then wander into the ectoderm. The sperm, however, originates and remains in the ectoderm.

Nemopsis sp. (see page 173).

Van Breeman, 1907, Tijdschr. Nederland. Dierk. Ver., Ser. 2, Bd. 10, p. xxiv.

Van Breeman records the capture of medusæ of *Nemopsis* in the Zuiderzee, Holland.

Rathkea octopunctata (see page 177).

Rathkea octopunctata, Braem, 1908, Biolog. Centralblatt, Bd. 28, p. 70, fign. 1–5.
Lizzia octopunctata, Bigelow, 1909, Proc. National Museum, Washington, vol. 37, p. 306, plate 31, figs. 3-5.

Braem contends that the process of formation of medusa-buds upon the manubrium of *Rathkea octopunctata* and *Lizzia claperedei* is not comparable with ordinary budding such as in hydroids when both ectoderm and entoderm take part in the formation of the bud, but is a germinal process, the buds being composed entirely of germ-cells situated in the ectoderm. It is not known, however, that a single germ-cell gives rise to a bud, but the daughter medusa may be formed by an aggregation of such cells, and until the exact mode of formation of the early stages of the daughter medusæ is demonstrated we can not be certain whether to regard the process as being one of budding or of germination. Braem, however, shows strong evidence, in so far as it extends, to support the belief that we have here a germinal process. If this be the case it may be in some measure comparable to the formation of certain tumors in higher animals.

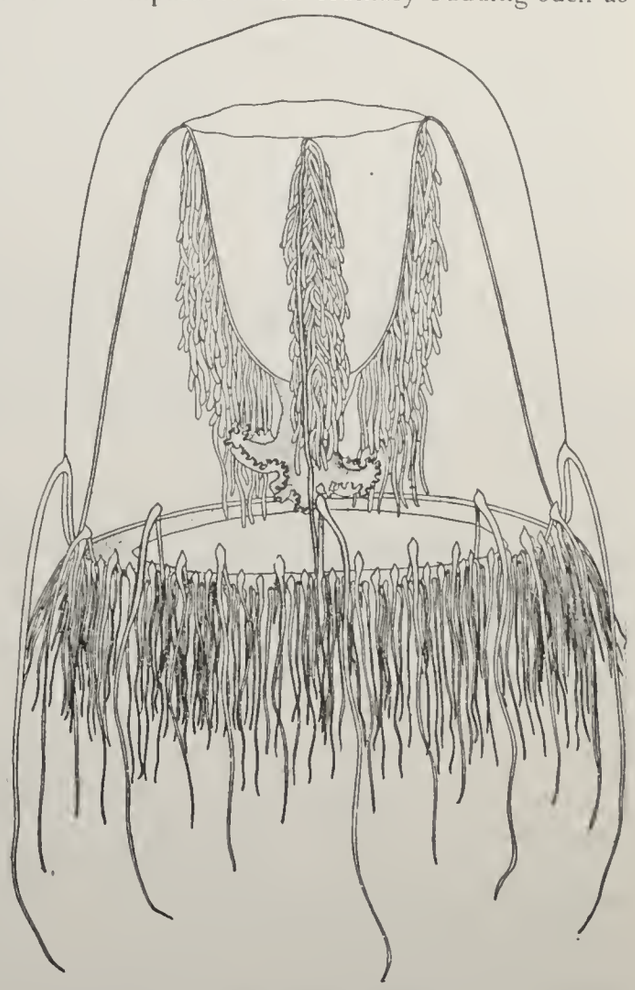

Fig. 327.—*Scrippsia pacifica*, after Torrey, in University of California Publications in Zoology.

Genus Scrippsia Torrey, 1909.

Scrippsia, Torrey, 1909, Publications University of California, Zool., vol. 6, p. 14.

This genus resembles the closely allied *Polyorchis* (see page 218), but is distinguished by its gelatinous, gastric peduncle and the absence of pinnate branches on the radial-canals distal to the gonads. The gonads are long and tubular as in *Polyorchis*, but are confined to the radial-canals over the peduncle.

The type species is *Scrippsia pacifica* from the coast of California.

Scrippsia pacifica Torrey.

Scrippsia pacifica, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 15, fig. 3.

Umbrella 75 mm. high, deep bell-shaped with a slight apical prominence. The tentacles are long and tapering and arranged in 7 cycles: 4, 4, 8, 16, 32, 64, 128. The 4 perradial tentacles are the longest and project from the sides of the exumbrella at a zone one-fifth the

distance toward the apex above the margin. The interradial, adradial, etc., tentacles also project from the sides of the exumbrella but at successively lower levels, nearer the bell-margin. All of the tentacles are joined by peronial strands to the ring-canal. The tentacle bases of the last two cycles bear ocelli. The gastric peduncle is broadly conical and more than half as long as the depth of the subumbrella cavity. The manubrium is short with 4 fairly prominent, frilled lips. The gonads are elongate, pendant, and sausage-shaped and confined to the gastric peduncle where they are developed in great numbers along the 4 radial-canals. The parts of the radial-canals over the subumbrella are narrow and devoid of side branches. Manubrium, gonads, and tentacles pale yellow, canals yellow, occasionally carmine. Found along the coast of California northward to Monterey and San Francisco, from 19 to 86 fathoms. Surface in Oakland Harbor and at La Jolla, California.

This is one of the largest and most beautiful of the Hydromedusæ.

Ptychogena californica Torrey.

Ptychogena californica, Torrey, 1909, Publications University of California, Zool., vol. 6, p. 13, figs. 1 and 2.

Bell 10 mm. wide, more than half as high as broad. About 48 tentacles, with thickened, compressed bases and slender filaments. 1 to 5 cordyli between every two tentacles. The cordyli mounted on prominent basal-bulbs as in *Staurophora*. Manubrium shallow, about half as wide as the bell and with large mouth without lobes. Gonads with 12 to 14 folds in the proximal half of each radial-canal. Two specimens off San Diego, California, in a vertical haul from 210 fathoms. Color (?)

Obelia purpurea Torrey.

Obelia purpurea, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 20, fig. 6.

This *Obelia* medusa is 3 to 4 mm. in diameter and has 110 to 160 tentacles. Its only distinctive character is the violet-purple color of its tentacle-bulbs and its yellow manubrium, canals, and gonads. It is found off San Diego, California, in winter and summer, at the surface and down to a depth of 160 fathoms.

Obelia nigrocaulus Hilgendorf.

Obelia nigrocaulus, Hilgendorf, 1898, Trans. and Proc. New Zealand Institute, vol. 30, p. 203, plate 17, figs. 1, 1*a*.

This species is distinguished by the dense black color of the basal parts of the stems. The mid-regions of the stems are brown and the distal branches transparent. Gonosome unknown. Hydrothecæ oval, with entire orifices. New Zealand.

Obelia commissuralis (see page 244).

Obelia commissuralis, Norton, 1896, American Monthly Microscop. Journal, vol. 17, p. 291, 12 figs.

A good account of the anatomy and life-history of the hydroid.

Obelia bifurca Hincks (see page 254).

Obelia bifurcata, Thornely, 1908, Journal Linnean Soc. London, Zool, vol. 31, p. 81, plate 9, fig. 2.—Billard, 1906, Expeditions Sci. *Travailleur* et *Talisman*, tome 8, p. 168.

Miss Thornely describes this species from Khor Shinab, Sudanese Red Sea, 10 to 12 fathoms. She is the first to observe the gonothecæ which are conical and not much larger than the hydrothecæ, and are borne upon pedicels with about 5 rings each. The stems of the hydroid are slightly branched.

Tiaropsis kelseyi.

Tiaropsidium kelseyi, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 19, fig. 5.

Bell flatter than a hemisphere, 50 mm. wide. 8 large and about 24 to 40 small, apparently rudimentary tentacles. 8 adradial sense-organs as in other species of *Tiaropsis*. Manubrium wider than in *T. diademata*. The gonads are more folded and more curtain-like than in *Tiaropsis diademata*, and are developed along the entire lengths of the radial-canals. Color as

in *T. diademata*, the manubrium, gonads, and tentacles being faint yellow. Found between San Diego and Monterey, California, from 50 to 200 fathoms.

Torrey proposes to separate the old genus *Tiaropsis*. He would retain the name *Tiaropsis* to describe all forms having tentacles of only one sort, and *Tiaropsidium* to designate medusæ having some well-developed and some rudimentary tentacles. A realization of the constant difficulty in distinguishing between rudimentary and merely young and undeveloped tentacles prevents me from accepting these distinctions.

Phialidium languidum (see page 269).

Phialidium lomæ, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 22, fig. 8.

I can not distinguish this California medusa from the common *Phialidium languidum* of the Atlantic coast of North America.

Genus Phialopsis Torrey, 1909.

Phialopsis, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 23.

The type species is *Phialopsis diegensis* of San Diego, coast of California. The genus is similar to *Phialucium* but with cirri upon the bell-margin.

Phialopsis diegensis Torrey.

Phialopsis diegensis, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 23, fig. 9.

Bell flat, 23 mm. wide, moderately thick walled. 16 to 28 well-developed tentacles, 5 to 9 rudimentary tentacles between each two long tentacles. Cirri somewhat more numerous than the rudimentary tentacles. 60 to 100 lithocysts each with 2 to 6 concretions. Manubrium short with cruciform base and broad, fluted lips. Gonads linear on outer three-fourths of the 4 radial-canals. Color (?) Found at San Diego, California, May to July, from the surface to a depth of 160 fathoms.

Eucheilota bakeri.

Phialium bakeri, Torrey, 1909, University of California Publications, Zool., vol. 6, p. 21, fig. 7.
Clytia bakeri, Torrey 1906, *Ibid.*, vol. 2, p. 323.

This medusa is set free from the hydroid described by Torrey, 1904 (*Ibid.*, vol. 2, p. 16), as *Clytia bakeri*. When set free the bell is oval, thin-walled, with 2 well-developed and 2 small, immature tentacles. 4 radial-canals. 2 gonads, 4 lithocysts. Cirri flank the basal-bulbs of the large tentacles. The 2 ovate gonads are upon the middle points of the 2 radial-canals in the radii of the long tentacles. The hydroid is found attached to clams and other mollusks upon sandy flats along the coast of California from Oceano to San Diego. The mature medusa is unknown. The young medusa recalls the condition seen in *Eucheilota dipleuron* from the North Carolina coast.

Eutima brownei.

Eutimalphes brownei, Torrey, 1909, University of California Publications, Zool, vol. 6, p. 25, fig. 10.

Bell nearly spherical, evenly rounded, thick at apex, and about 15 mm. in diameter. About 130 short tentacles with bulbous bases, each flanked by 1 to 3 pairs of long, slender cirri. No marginal papillæ. 8 adradial lithocysts with 6 to 13 concretions in each. Manubrium short and broad with 4 wide, frilled lips. Peduncle wide, conical, and about as long as the depth of the bell-cavity. Gonads 4 narrow bands upon the subumbrella lengths of the 4 radial-canals. Gonads with straw-yellow entoderm and turquoise-blue ectoderm. Tentacles with red-brown entoderm and turquoise-blue ectoderm. Found on the surface in June and July at San Diego, California.

Only 10 out of 90 specimens possessed cirri. During growth the gonads extend outward along the radial-canals.

Eutima campanulata (?) (see page 302).

Octorchandra orientalis, Hartlaub, 1909, Zoologische Jahrbücher, Abth. Syst., Bd. 27, p. 456, taf. 20, fign. 11–15.

Hartlaub states that this medusa from Djibuti, east coast of Africa, is closely allied to Haeckel's *O. germanica* of the German coast, but differs in its large bell, thick gelatinous walls, and relatively short peduncle. In the African medusa bell is 15 mm. wide and peduncle

as long as bell-radius. About 13 well-developed tentacles without swollen basal-bulbs. A few cirri on the sides of the tentacle-bases. A few marginal warts all on the exumbrella side of the ring-canal. There are 8 gonads, 2 on each radial-canal; a small oval gonad in the mid-region of the peduncle and one from the base of the peduncle to near the bell-margin on each radial-canal. Hartlaub describes the medusa from two specimens, both apparently immature. It is probably only a variety of *E. campanulata*. It is not identical with *Eutima orientalis* described by Browne from Ceylon.

Eutima modesta.

Eutimalphes modesta, HARTLAUB, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 454, taf. 19, fign. 6, 7.

Bell about 8 mm. wide, flat, and thin-walled. Peduncle slender, tapering, and about as long as bell-radius. Stomach small, with 4 pointed lips, 4 narrow radial-canals with 4 linear gonads a little nearer to peduncle than to margin. There are 16 well-developed tentacles with swollen basal-bulbs flanked by cirri and there are also 16 or more tentacle-bulbs each with 1 or 2 lateral cirri. 8 large oval adradial lithocyst-capsules. Number of concretions (?) A single specimen from Djibuti, east coast of Africa, May 14, 1904. This species is closely related to *E. cærulea* of the West Indies, but is distinguished by its thin-walled bell, fewer tentacles, and shorter gonads. (See synoptic table of species of *Eutima* on page 296.)

Eirene pellucida (see page 314).

Irene pellucida, HARTLAUB, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 448, taf. 19, fign. 5, 8–10.

Hartlaub identifies this Mediterranean medusa from a single specimen from Djibuti, east coast of Africa. The gonads are, however, nearer to the bell-margin than in the Mediterranean form according to Claus, but Hartlaub finds that in some specimens from Trieste the gonads are similar to the African medusa in form and position, and indeed in Will's, 1844, figure the gonads on the subumbrella parts of the radial-canals are near the bell-margin.

Studies at Naples inclined me to conclude that *Eirene pellucida* Will is only the young of *Tima lucullana*, but Hartlaub's African medusa is apparently not the young of a *Tima*, and I now believe that I was mistaken in supposing that *Eirene pellucida* is the young of a *Tima*.

Will, 1844, gives a clear description of *Eirene pellucida* from Trieste. Bell 25 mm. wide, nearly hemispherical, thick-walled. About 64 tentacles, the longest half as long as the bell-radius. Numerous marginal warts and cirri. An irregular number (40 or more) of lithocysts each with 1 to 9 spherical concretions. Velum narrow. Peduncle tapering, not very wide, and flaring at base, and only about as long as the bell-radius. Stomach small with 4 simple lips. When young there are 8 gonads upon the radial-canals, 4 on the peduncle, and 4 on the subumbrella near the ring-canal, but later the gonads fuse into 4 long, linear tracts. Medusa colorless with the exception of the stomach, gonads, and tentacle-bulbs which are opaque white or blue, green or yellow.

Tima lucullana (see page 314).

Tima flavilabris, STIASNY, 1908, Arbeit. Zool. Inst. Univ. Wein, Bd. 17, p. 221, taf. 1, fign. 1–5.

Stiasny finds a medusa at Trieste, Adriatic, in November and March, which he believes to be identical with *Tima flavilabris* of the Atlantic. The larger of his two specimens was found in March. Bell 68 mm. wide, 35 mm. high, 64 long tentacles, about 15 irregularly placed lithocysts each with 5 to 8 concretions. The gonads extend along the entire lengths of the radial-canals.

Stiasny's medusa appears to me to possess all of the essential characters of *T. lucullana*. *Tima flavilabris* of Eschscholtz is indeed imperfectly known, but its numerous short tentacles separate it from Stiasny's medusa.

Æquorea parva Browne (see page 334).

Æquorea parva, HARTLAUB, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 459, taf. 21, fign. 21–26.

Two specimens from Djibuti, east coast of Africa, on May 13, 1904. The largest had a bell 10 mm. wide, with thick gelatinous wall and shallow bell-cavity. Stomach flat, about half as wide as bell-diameter. 28 spur-shaped, fairly long, simple lips each with a short radial-muscle. 28 radial-canals each with a gonad about half as long as the canal, leaving

both ends free. 4 large, perradial tentacle-bulbs, with well-developed tentacles, and about 75 to 100 small marginal bulbs without tentacles, the 4 interradial ones being somewhat larger than the others. These bulbs bear no relation in arrangement to the radial-canals. Each of the small tentacle-bulbs bears a simple ectodermal ocellus on its outer side. There are about twice as many lithocyst-capsules as tentacle-bulbs, each with 2 concretions. Velum narrow. Gonads light reddish-yellow, other parts colorless.

Amphogona pusilla Hartlaub.

Amphogona pusilla, Hartlaub, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 462, taf. 21, fig. 27.

Bell 1.5 mm. wide, nearly hemispherical, and thin-walled. 16 well-developed, contractile tentacles covered with prominent nettling-cells and rolled into helices. The 8 radial tentacles longer than interradial. Velum fairly wide and bestrewn with groups of very small nettling-cells. Sensory-clubs (?) Peduncle short, conical. Stomach small with 4 simple, pointed lips. 8 narrow, straight radial-canals with 8 spherical gonads upon the middle of their distal halves.

In one of Hartlaub's specimens 4 male gonads alternated with 4 female, but in the other specimen all of the gonads were unisexual and female. It will be remembered that in Bigelow's specimens of *Amphogona* the gonads of each specimen were unisexual, while Browne found only bisexual specimens. It seems, therefore, that the hermaphroditic condition is developed only in certain individuals, as is apparently the case in *Chrysaora* among Scyphomedusæ. Hartlaub records two specimens of *Amphogona pusilla* from Djibuti, East Africa, in May. It is distinguished from *A. apsteini* by its small number of tentacles (see page 405).

Liriope rosacea Eschscholtz (see page 417).

Liriope rosacea, Hartlaub, 1909, Zoologische Jahrbücher, Abth. Syst., Bd. 27, p. 466, taf. 22, fign. 28, 31, 32.

Hartlaub describes this medusa from the coast of East Africa.

Liriope haeckeli Goette (see page 421).

Liriope haeckeli, Hartlaub, 1909, Zoologische Jahrbüch., Abth. Syst., Bd. 27, p. 464, taf. 22, fign. 29, 30, 33.

Bell 12 mm. wide, 5 mm. high, gelatinous substance thick. Peduncle together with stomach one-and-one-half times as long as bell-diameter. Peduncle 4-sided, pyramidal, slender, and arising abruptly from subumbrella without a flaring base. Gonads triangular with blunt, broad outer points, concave sides and rounded angles. They are developed upon the distal three-sevenths of the broad radial-canals close to the ring-canal and are narrower than the arcs between them. 3 wide, bluntly-ending centripetal canals in each quadrant. Coast of Zanzibar, September, 1885. Color (?)

Gonionemus murbachii Perkins (see page 343).

Gonionemus murbachii, Terry, 1909, Am. Journ. Physiol., vol. 17, p. 354.—Morris, 1909, Proc. Biol. Soc. Washington, vol. 22, p. 179.—Murbach, 1909, Biol. Bulletin Woods Hole, vol. 17, p. 354.

Terry finds that in normal sea-water H_2O_2 initiates pulsation in the marginless bell of *Gonionemus* by increasing the oxidative processes. Pulsations are caused by oxygen in alkaline, but not in normal sea-water, for oxidation occurs more rapidly in alkaline than in neutral or acid media.

Morris states that Mayer's designation *Gonionemus murbachii* is a *nomen nudum* for this author merely calls attention to the *difference* between the then existing descriptions of *G. vertens* by A. Agassiz, and of the Woods Hole medusa by Murbach, and does not present a new description of the medusa. Thus happily we may designate as the author of the species, Perkins, whose graphic account of the appearance, habits, and development of this medusa is quoted at length in this volume.

Murbach studies the light-reactions of the medusa and concludes that the animal does not usually direct its movements to favorable locations, but swims at random until it comes into a favorable environment where it settles down. The medusa turns away from intense light. Change in the intensity of light produces a reaction on the part of the medusa. Inhibition of

movement occurs in pronounced decrease in the intensity of light. Relative intensity in the field, not ray-direction, determines the place of rest. Light is necessary for the up-swimming activity, though not for directive—this being due to gravity. Contact of the bell with air and the accompanying recoil probably cause the inhibition that precedes inversion of the bell at the surface.

This paper should be read in connection with those of Yerkes and Ayers, 1903, in American Journal of Physiol., vol. 9, and of Morse, 1907, in American Naturalist, vol. 41.

Æginopsis laurentii (see page 472).

Æginopsis laurentii, Bigelow, H. B., 1909, Proc. National Museum, Washington, vol. 37, p. 314, plate 32, figs. 2-6.

Bigelow records the capture of 46 specimens of this little-known medusa by Bryant from off the coasts of Labrador and Newfoundland during the summer of 1908. The largest is 13 mm. in diameter. There are 4 tentacles and 8 peronial strands The 16 gastric pockets of the adult are derived by subdivision from 8 primary pockets. There is no peripheral canal system. There are 16 to 26 lithocyst-clubs each with 1 to 3 large concretions. No otoporpæ. Gonads in the ectoderm of the subumbrella wall of the 16 gastric pockets.

Bigelow's description, accompanied as it is by clear photographs of the medusa, is the best extant.

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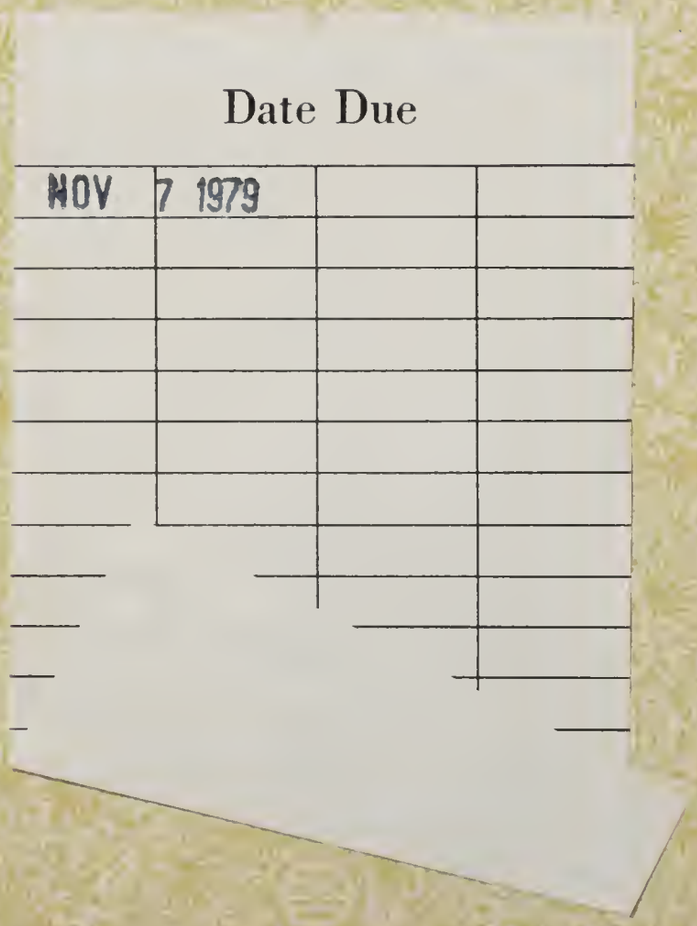
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